



US Army Corps
of Engineers
New England Division

Drought Contingency Plan

JULY 1992

Mansfield Hollow Lake, Mansfield Hollow, Connecticut



SUMMARY

DROUGHT CONTINGENCY STORAGE FOR EMERGENCY WATER SUPPLY PURPOSES AT MANSFIELD HOLLOW LAKE IS SPONSORED BY THE STATE OF CONNECTICUT

In letter, dated June 12, 1991 (copy in Appendix D), the State of Connecticut Department of Health Services has identified themselves as the lead Agency to act as sponsor for the Mansfield Hollow Lake Drought Contingency Plan.

Requirements for Environmental Compliance Prior to Implementation of Drought Contingency Plan

Prior to implementation of drought contingency storage, an updated Environmental Assessment (EA) will be prepared in accordance with the National Environmental Policy Act (NEPA) of 1969. The existing EA, prepared in 1977, does not address the environmental impacts related to this drought contingency plan. The new assessment will address impacts to water quality, wetlands, aquatic and terrestrial habitats and historic as well as archeological resources resulting from storage of water during a drought emergency. In addition, the new assessment will analyze compliance of the proposed action with Federal, State and local environmental regulations and will be coordinated with appropriate Federal and State Agencies. This requirement to prepare an Environmental Assessment must be fulfilled even in the event of a declared drought emergency.

DROUGHT CONTINGENCY PLAN
MANSFIELD HOLLOW LAKE

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DROUGHT CONTINGENCY PLAN
MANSFIELD HOLLOW LAKE

1. PURPOSE AND SCOPE

The purpose of this study and report was to develop and set forth an emergency drought contingency storage plan for operation of Mansfield Hollow Lake that would identify how the New England Division could render assistance to the State of Connecticut during State declared drought emergencies affecting domestic, municipal and industrial water supplies. The scope of this report was not to address the feasibility of providing a permanent water supply pool at Mansfield Hollow Lake, but rather to address the use of a temporary short term pool during a drought emergency. Assistance would be provided through flexibility of regulation and use of existing storage at Mansfield Hollow Lake. The plan is considered to be within the currently existing water control plan for this project. Included are descriptions of present operating regulations, existing water supply conditions, plan for utilization of short term emergency storage during a drought, a water quality evaluation, drought storage/releases cost, impacts on other project purposes, identification of a State sponsor, and a conclusion.

2. AUTHORIZATION

Authority for drought contingency plans is contained in ER 1110-2-1941, dated 15 September 1981, which provides that water control managers continually review and when appropriate, adjust water control plans in response to changing public needs. Drought contingency plans will be developed on a regional, basin-wide or project basis as an integral part of water control management activities and in accordance with an approved water control plan.

3. PROJECT AUTHORIZATION CONDITIONS

Mansfield Hollow Lake was authorized by the Flood Control Act of 18 August 1941 (Public Law 228, 77th Congress). In addition, Section 4 of the Flood Control Act of 22 December 1944 (Public Law 534, 78th Congress) authorized the development and use of a recreational pool at the project.

4. PROJECT DESCRIPTION

Mansfield Hollow Lake, constructed in 1952, in Mansfield Hollow, Connecticut, is located on the Natchaug River about 5.3 miles upstream from its confluence with the Shetucket River at Willimantic, Connecticut (see plate 1). Normal

elevation of the permanent pool at Mansfield Hollow is 206.5 feet NGVD (11.5 foot depth) having a total storage volume of about 1,000 acre-feet. A recreation pool is maintained during the summer months at elevation 211.5 feet NGVD (16.5-foot depth), with a surface area of 450 acres and total storage of 2800 acre-feet of water. An additional 49,200 acre-feet of storage are available above the recreation pool level for flood control purposes up to spillway crest elevation 257.0 feet NGVD, equivalent to 5.8 inches of runoff from the project's 159-square mile drainage area. Area-Capacity data for Mansfield Hollow Lake are shown on plate 2.

• The outlet works consist of five 5 foot 6 inches wide by 7 feet 0 inch high conduits in the concrete spillway section. Conduits 3 and 4 have inverts at elevation 195.0 feet NGVD and conduits 1, 2 and 5 have inverts at elevation 199.0 feet NGVD. Each conduit is provided with one hydraulically operated service gate with individual controls.

5. PRESENT OPERATING REGULATIONS

a. Normal Periods. During the nonfreezing season, a 16.5-foot deep recreation pool is maintained by a concrete weir and stoplog structure located upstream of gate 1. The pool is maintained at elevation 211.5 feet NGVD from May to November. During the winter season the pool is lowered to an 11.5-foot depth to elevation 206.5 feet NGVD and maintained by a concrete weir and stoplog structure upstream of gate 2 from November to May. During periods of normal flow, outflow is maintained equal to inflow by allowing all inflow to pass through the dam.

b. Flood Periods. Regulation of flows from Mansfield Hollow is initiated for heavy rainfall over the Shetucket River watershed and for specific river stages at key index stations along the river. Regulation may be considered in three phases: Phase I - appraisal of storm and river conditions during development of the flood; Phase II - flow regulation and storage of flood runoff at the reservoir while the Shetucket and/or Quinebaug River floodflows crest and move downstream, and Phase III - emptying the reservoir following downstream recession of the flood. A minimum release of about 15 cfs is maintained only during periods of flood control regulation in order to sustain downstream fish life. The maximum nondamaging discharge capacity immediately downstream of Mansfield Hollow is about 2,900 cfs. Releases at or near this rate can be expected whenever peak inflows exceed this value and climatologic as well as hydrologic conditions permit such releases.

c. Monitoring. The Reservoir Control Center directs reservoir regulation activities at 28 manned New England Division flood control dams and continually monitors rainfall, snow cover, and runoff conditions throughout the region. When any of these hydrologic parameters have been observed to be well below normal for several months and it appears that possible drought conditions might be developing, the Corps Emergency Operations Center (EOC) will be informed. The EOC will then initiate discussions with the respective Federal and State agencies and other in-house Corps elements to review possible drought concerns and future Corps actions.

d. Downstream Non-Federal Project. Located about two miles downstream of Mansfield Hollow Lake is the Willimantic Reservoir Dam owned by the Willimantic Water Works, town of Windham, Connecticut. The reservoir has an estimated total volume at spillway crest of 750 acre-feet or 244 million gallons and serves as the sole source of drinking water for Water Department customers. Water supply withdrawal is accomplished through a screen chamber located in the pump house on the west abutment of the dam. The average demand for water from the reservoir is about 2.5 million gallons per day (MGD) and is drawn on demand. Releases from Mansfield Hollow Lake are the primary source of inflow to the Willimantic Reservoir.

6. DESCRIPTION OF EXISTING WATER SUPPLY CONDITIONS

a. General. Tables 1 and 2 present information concerning the existing water supply system within Tolland, Windham, and New London Counties in eastern Connecticut. The tables have been formulated using available data provided by the State of Connecticut Department of Environmental Protection. Data provided from the major water suppliers included a computer printout of 1980 water utility records, a summary of surface water sources within the study area, and information on groundwater sources where available. Estimates of safe yields of existing surface and/or groundwater supplies were provided where available. In many instances, particularly for smaller water supplies, portions of the data are missing. No effort by the Corps was made to develop and accumulate any of this missing data as it was considered beyond the detail level required for this study.

b. Water Supply Systems. The primary objective of this analysis was to accumulate available data regarding water supply systems in the vicinity of Mansfield Hollow Lake that could benefit from storage in the lake and present it in a manner portraying existing water supply conditions. Projections of future demands were not developed because this study

TABLE 1

Major Water Suppliers - Eastern Connecticut

Company	Towns Served	Est. Population Served	Source of Supply		Water Production 1980 - MG		Est. Safe Yield MGD		
							Surface	Ground (Active)	Ground (Inactive)
Northern Div., Conn. Water Co.	East Windsor	2849	x	x	165.9	1361.7	0.600	-	
	Enfield	21689							
	South Windsor	6591							
	Stafford	2622							
	Suffield	5317							
	Vernon	171							
	Windsor Locks	12365							
Rockville Div., Conn. Water Co.	Ellington	749	x		1121.5		13.000		
	Tolland	161							
	Vernon	14081							
Mystic Valley DS, CT-AM Water Co.	Groton	4321	x	x	378.9	76.5	-	-	1.080
	Stonington	5259							
Crystal Water Co. of Danielson	Killingly	7500	x	x	204.4	179.0	0.800	-	
	Brooklyn	1700							
Jewett City Water Co.	Griswold	5650	x	x	179.7	57.8	0.500	0.432	
	Lisbon	102							
Lifetime Homes Inc. Water Div.	Ledyard	3200		x		57.9		0.259	0.097
Thompson Water Co.	Thompson	3600		x		99.6		-	
Groton Utilities Dept.	Groton	33200	x		4416.6		-		
Manchester Water Dept.	Manchester	49500	x	x	955.7	968.0	1.920	-	
New London Water Dept.	New London	-	x		1967.5		-		
	Waterford	-							
	Montville	-							
Norwich Public Utilities Dept.	Bozrah	390	x		1552.5		3.850	1.200	
	Lebanon	20							
	Montville	275							
	Norwich	43500							
	Preston	1000							
Putnam Water Dept.	Putnam	6710	x	x	468.7	136.7	-	-	
	Thompson	70							
	Woodstock	138							
Vernon Water Dept.	Vernon	3400		x		98.9		.918	

TABLE 1 (Continued)

Major Water Suppliers - Eastern Connecticut

Company	Towns Served	Est. Population Served	Source of Supply Surface Ground	Water Production 1980 - MG		Est. Safe Yield MGD		
				Surface	Ground	Surface	Ground (Active)	Ground (Inactive)
N. Stonington Div., SCWA	N. Stonington	808	x		14.4		.140	
Tower Div., SCWA	Ledyard	2040	x		45.0		.632	
Somers Sec., No. Div., CTWC	Somers	1246	x		-		.194	
Stafford Sec., No. Div., CTWC	Stafford	2622	x	165.9	-	-		
Country Hills, Elm Water Co.	Tolland	368	x		-		.229	.030
Coventry Hills, Elm Water Co.	Coventry	400	x		-		.062	.033
Pilgrim Hills, Elm Water Co.	Coventry	352	x		-	-		
Lake Amston Div., A & B Water Co.	Hebron Lebanon	500 500	x		-		.118	
Lakeview Terr. WSC, Helms Inc.	Coventry	530	x		-		.025	.016
Nathan Hale Hgt. WSC, Helms Inc.	Coventry	160	x		-	-		
Arpin CT., Trask Art. Well Co.	Norwich	60	x		-		.022	
Lawler CT., Trask Art. Well Co.	Norwich	100	x		-		.011	
Moosup Sup., Trask Art. Well Co.	Plainfield	220	x		-		.035	

TABLE 1 (Continued)

Major Water Suppliers - Eastern Connecticut

Company	Towns Served	Est. Population Served	Source of Supply Surface Ground	Water Production 1980 - MG		Est. Safe Yield MGD	
				Surface	Ground	Surface (Active)	Ground (Inactive)
Oakdale Heights Assoc.	Montville	860	x		23.6	.205	.043
Occum Water Co.	Norwich	396	x		6.0	.070	
P & A. Memorial Water Supply Co.	Killingly	332	x		-	.076	
South Coventry Water Supply Co.	Coventry	600	x		-	.075	
Sterling Water Co.	Sterling	200	x		-	-	
Tolland Aqueduct Co.	Tolland	375	x		6.4	.130	
Tolland Summit Com. Water Assoc.	Tolland	257	x		5.0	.016	.034
Trask Artesian Well Co.	Norwich Plainfield	160 220	x		-	-	
Williamsville Water Co.	Killingly	530	x		-	-	
Woodland Summit Com. Water Assoc.	Tolland	250	x		5.6	-	
Heritage Woods Water Co.	Tolland	275	x		4.9	.076	
Westerly Water Dep. Pawcatuck Sec.	Stonington	2400	x		-	5.250	
University of Conn.	Mansfield	21700	x		-	2.052	
Barrelet Div. SCWA	Ledyard	270	x		4.7	.043	.016
Ferry View Heights Div. SCWA	Ledyard	300	x		6.1	.067	
Gray Farms Div., SCWA	Ledyard	180	x		3.2	-	
Lantern Hill Div., SCWA	Stonington	84	x		1.4	.084	
Mohegan Div., SCWA	Montville	1300	x		23.8	.173	
Montville Div., SCWA	Montville	1700	x		36.0	.130	.99

TABLE 1 (Continued)

Major Water Suppliers - Eastern Connecticut

Company	Towns Served	Est. Population Served	Source of Supply Surface Ground	Water Production 1980 - MG		Est. Safe Yield MGD		
				Surface	Ground	Surface	Ground (Active)	Ground (Inactive)
Willimantic Water Dept.	Mansfield Windham	1000 15400	x	874.5		6.000		
Ellington Acres Inc.	Ellington	1850	x		56.9		.154	.119
Elm Water Co.	Coventry Tolland	344 756	x		-		-	
Gallup Water Service Co.	Plainfield	1700	x		257.0		1.620	.700
Plainfield Water Co.	Plainfield	1200	x		120.6		-	
Colchester Water Dept.	Colchester	3500	x		115.8		.565	
Spragne Water And Sewer Auth.	Sprague	3100	x	42.8		.211		
Amston & Beseck Water Co.	Hebron Lebanon Middlefield	500 500 500	x		5.5		-	
Cedar Ridge Water Assn.	N. Stonington	450	x		10.0		.214	
Country Squire Water Co.	Preston	275	x		8.1		.041	
Ellington Water Co.	Ellington	365	x		-		.043	
General Water Service Co.	Coventry	464	x		-		.076	
Kittamaug Orchard Assn.	Montville	.80	x		7.5		.075	
Lake Hoyward Water Co.	East Haddam	2800	x		5.4		.108	
Helms, Inc.	Coventry	530	x		-		-	
Lakewood Heights Water Supply	Coventry	210	x		4.0		.029	
Lebanon Water Co.	Lebanon	228	x		5.0		.022	
Llynwood, Inc.	Bolton	84	x		1.7		.032	.018
Moosup Water Works	Plainfield	500	x		7.5		.039	.032
Waterford Village Water Co.	Waterford	440	x		10.2		.056	.024

TABLE 2

CONNECTICUT INTERIM LONG RANGE POPULATION PROJECTIONS

Town Name	Census Counts		OPM Interim Population Projections				Long Range Projections		
	1980	1990	1995	2000	2005	2010	2020	2030	2040
Andover	2,144	2,540	2,790	2,990	3,090	3,190	3,500	3,900	4,300
Ansonia	19,039	18,403	17,560	17,100	16,500	15,950	14,900	13,800	12,700
Ashford	3,221	3,765	4,190	4,370	4,560	4,700	5,200	5,700	6,200
Avon	11,201	13,937	16,310	17,400	18,300	19,290	22,100	24,800	27,600
Barkhamsted	2,935	3,369	3,830	4,060	4,140	4,140	4,600	5,000	5,400
Beacon Falls	3,995	5,083	5,590	5,700	5,750	5,750	6,300	6,900	7,500
Berlin	15,121	16,787	17,820	18,180	18,340	18,390	19,500	20,600	21,700
Bethany	4,330	4,608	4,810	4,910	4,910	4,910	5,100	5,300	5,500
Bethel	16,004	17,541	18,600	19,220	19,660	20,050	21,400	22,800	24,200
Bethlehem	2,573	3,071	3,270	3,370	3,420	3,470	3,800	4,100	4,400
Bloomfield	18,608	19,483	20,130	20,280	20,230	20,080	20,600	21,100	21,600
Bolton	3,951	4,575	4,920	5,070	5,170	5,220	5,600	6,100	6,500
Bozrah	2,135	2,297	2,540	2,700	2,780	2,860	3,100	3,400	3,600
Branford	23,363	27,603	29,680	30,650	31,260	31,620	34,400	37,200	39,900
Bridgeport	142,546	141,686	141,330	140,980	140,890	140,800	140,200	139,600	139,000
Bridgewater	1,563	1,654	1,790	1,870	1,960	2,000	2,200	2,300	2,500
Bristol	57,370	60,640	60,800	60,950	60,430	59,330	59,900	60,600	61,200
Brookfield	12,872	14,113	14,910	15,360	15,610	15,660	16,600	17,600	18,600
Brooklyn	5,691	6,681	7,340	7,700	7,960	8,160	9,000	9,800	10,700
Burlington	5,660	7,026	7,870	8,390	8,820	9,050	10,200	11,400	12,500
Canaan	1,002	1,057	1,200	1,240	1,240	1,290	1,400	1,500	1,600
Canterbury	3,426	4,467	4,830	5,030	5,240	5,390	6,000	6,700	7,300
Canton	7,635	8,268	8,430	8,480	8,430	8,220	8,400	8,600	8,800
Chaplin	1,793	2,048	2,230	2,270	2,310	2,400	2,600	2,800	3,000
Cheshire	21,788	25,684	28,090	29,120	29,990	30,810	33,800	36,900	39,900
Chester	3,068	3,417	3,470	3,470	3,470	3,420	3,500	3,600	3,700
Clinton	11,195	12,767	14,050	14,770	15,340	15,820	17,400	19,000	20,600
Colchester	7,761	10,980	13,260	14,780	16,290	17,960	21,400	24,800	28,200
Colebrook	1,221	1,365	1,640	1,740	1,810	1,840	2,100	2,300	2,500

TABLE 2 (cont)

CONNECTICUT INTERIM LONG RANGE POPULATION PROJECTIONS

Town Name	Census Counts		OPM Interim Population Projections				Long Range Projections		
	1980	1990	1995	2000	2005	2010	2020	2030	2040
Columbia	3,386	4,510	5,460	5,930	6,410	6,830	8,000	9,200	10,400
Cornwall	1,288	1,414	1,410	1,410	1,360	1,310	1,300	1,300	1,300
Coventry	8,895	10,063	10,570	10,970	11,230	11,480	12,300	13,200	14,100
Cromwell	10,265	12,286	13,390	13,790	14,090	14,340	15,700	17,100	18,400
Danbury	60,470	65,585	68,550	70,650	71,990	72,810	77,000	81,300	85,500
Darien	18,892	18,196	17,100	16,520	15,680	14,780	13,400	12,000	10,600
Deep River	3,994	4,332	4,580	4,680	4,780	4,930	5,200	5,600	5,900
Derby	12,346	12,199	11,850	11,490	11,090	10,630	10,000	9,400	8,900
Durham	5,143	5,732	5,940	6,050	6,050	6,000	6,300	6,600	6,900
East Granby	4,102	4,302	4,300	4,300	4,250	4,150	4,200	4,200	4,200
East Haddam	5,621	6,676	7,320	7,740	8,070	8,440	9,400	10,300	11,300
East Hampton	8,572	10,428	11,360	12,300	12,580	12,870	14,400	15,800	17,300
East Hartford	52,563	50,452	48,650	47,340	45,740	43,990	41,100	38,200	35,300
East Haven	25,028	26,144	26,830	26,980	26,830	26,490	27,000	27,500	28,100
East Lyme	13,870	15,340	15,960	16,280	16,430	16,430	17,300	18,200	19,000
East Windsor	8,925	10,081	10,410	10,580	10,630	10,630	11,200	11,700	12,300
Eastford	1,028	1,314	1,510	1,610	1,700	1,850	2,100	2,400	2,700
Easton	5,962	6,303	6,600	6,560	6,340	6,040	6,100	6,100	6,200
Ellington	9,711	11,197	12,790	13,760	14,560	15,090	17,000	18,900	20,800
Enfield	42,695	45,532	46,470	46,850	46,470	45,720	46,800	47,800	48,800
Essex	5,078	5,904	6,270	6,430	6,530	6,580	7,100	7,600	8,100
Fairfield	54,849	53,418	52,070	50,800	48,970	46,830	44,200	41,500	38,900
Farmington	16,407	20,608	22,560	23,480	24,020	24,350	27,000	29,600	32,300
Franklin	1,592	1,810	2,080	2,220	2,350	2,440	2,700	3,000	3,300
Glastonbury	24,327	27,901	30,030	30,900	31,350	31,510	34,000	36,400	38,900
Goshen	1,706	2,329	2,770	3,010	3,200	3,400	4,000	4,500	5,100
Granby	7,956	9,369	9,980	10,330	10,540	10,640	11,500	12,400	13,300
Greenwich	59,578	58,441	58,570	58,170	56,930	55,200	53,900	52,600	51,300
Griswold	8,967	10,384	10,590	10,750	10,910	11,070	11,700	12,400	13,000

TABLE 2 (cont)

CONNECTICUT INTERIM LONG RANGE POPULATION PROJECTIONS

Town Name	Census Counts		OPM Interim Population Projections				Long Range Projections		
	1980	1990	1995	2000	2005	2010	2020	2030	2040
Groton	41,062	45,144	48,110	49,000	49,050	48,760	51,400	54,100	56,800
Guilford	17,375	19,848	21,040	21,590	21,880	22,080	23,700	25,200	26,800
Haddam	6,383	6,769	7,150	7,330	7,430	7,470	7,900	8,200	8,600
Hamden	51,071	52,434	52,380	52,020	51,140	50,010	49,600	49,300	48,900
Hampton	1,322	1,578	1,670	1,720	1,810	1,900	2,100	2,300	2,500
Hartford	136,392	139,739	140,150	145,860	152,910	161,090	169,100	177,200	185,300
Hartland	1,416	1,866	1,980	2,090	2,090	2,140	2,400	2,600	2,800
Harwinton	4,889	5,228	5,480	5,580	5,680	5,730	6,000	6,300	6,600
Hebron	5,453	7,079	7,640	8,000	8,310	8,620	9,600	10,700	11,700
Kent	2,505	2,918	3,130	3,180	3,240	3,290	3,500	3,800	4,100
Killingly	14,519	15,889	16,530	17,030	17,520	18,020	19,200	20,300	21,500
Killingworth	3,976	4,814	5,030	5,140	5,140	5,190	5,600	6,000	6,300
Lebanon	4,762	6,041	7,470	8,340	9,080	9,820	11,600	13,300	15,100
Ledyard	13,735	14,913	16,000	16,650	17,690	17,840	19,300	20,800	22,300
Lisbon	3,279	3,790	4,030	4,280	4,350	4,420	4,800	5,200	5,600
Litchfield	7,605	8,365	8,820	8,970	9,030	9,180	9,700	10,200	10,700
Lyme	1,822	1,949	2,220	2,360	2,450	2,490	2,700	3,000	3,200
Madison	14,031	15,485	16,390	16,700	17,000	17,360	18,500	19,600	20,700
Manchester	49,761	51,618	52,420	53,210	53,430	53,640	55,000	56,300	57,600
Mansfield	20,634	21,103	21,950	22,280	22,750	23,080	23,900	24,800	25,700
Marlborough	4,746	5,535	6,820	7,590	8,370	9,020	10,500	12,000	13,500
Meriden	57,118	59,479	59,200	59,050	58,480	57,870	58,000	58,200	58,300
Middlebury	5,995	6,145	6,470	6,510	6,560	6,560	6,800	7,000	7,200
Middlefield	3,796	3,925	4,120	4,160	4,160	4,120	4,200	4,400	4,500
Middletown	39,040	42,762	42,910	43,290	43,400	43,290	44,600	45,900	47,200
Milford	50,898	49,938	49,540	49,200	48,220	46,890	45,600	44,400	43,200
Monroe	14,010	16,896	18,910	19,980	20,890	21,710	24,300	26,900	29,600
Montville	16,455	16,673	16,820	17,010	16,960	16,770	16,900	17,100	17,200
Morris	1,899	2,039	2,090	2,140	2,140	2,090	2,200	2,200	2,300

TABLE 2 (cont)

CONNECTICUT INTERIM LONG RANGE POPULATION PROJECTIONS

Town Name	Census Counts		OPM Interim Population Projections				Long Range Projections		
	1980	1990	1995	2000	2005	2010	2020	2030	2040
Naugatuck	26,456	30,625	33,200	34,910	36,170	37,290	41,000	44,700	48,300
New Britain	73,840	75,491	74,780	74,160	73,380	72,540	72,000	71,400	70,900
New Canaan	17,931	17,864	17,660	17,260	16,570	15,920	15,200	14,600	13,900
New Fairfield	11,260	12,911	13,640	13,740	13,590	13,530	14,300	15,000	15,700
New Hartford	4,884	5,769	6,170	6,420	6,570	6,620	7,200	7,800	8,400
New Haven	126,109	130,474	138,060	144,520	151,310	158,240	169,400	180,600	191,700
New London	28,842	28,540	27,800	27,750	27,750	27,700	27,300	26,900	26,500
New Milford	19,420	23,629	25,760	27,120	28,340	29,350	32,700	36,000	39,300
Newington	28,841	29,208	28,790	28,270	27,400	26,320	25,500	24,600	23,700
Newtown	19,107	20,779	21,540	21,950	22,150	22,400	23,500	24,600	25,700
Norfolk	2,156	2,060	2,240	2,340	2,430	2,470	2,600	2,700	2,900
North Branford	11,554	12,996	13,710	14,060	14,220	14,320	15,200	16,200	17,100
North Canaan	3,185	3,284	3,330	3,330	3,380	3,380	3,400	3,500	3,600
North Haven	22,080	22,247	22,680	22,580	22,190	21,700	21,600	21,500	21,500
North Stonington	4,219	4,884	5,350	5,580	5,770	5,910	6,500	7,100	7,600
Norwalk	77,767	78,331	79,460	79,970	79,320	77,720	77,900	78,200	78,400
Norwich	38,074	37,391	36,490	36,080	35,580	35,370	34,400	33,400	32,500
Old Lyme	6,159	6,535	6,630	6,630	6,530	6,490	6,600	6,700	6,800
Old Saybrook	9,287	9,552	10,020	10,160	10,160	10,210	10,500	10,900	11,200
Orange	13,237	12,830	12,730	12,430	11,990	11,550	11,000	10,500	9,900
Oxford	6,634	8,685	9,240	9,520	9,630	9,680	10,700	11,600	12,600
Plainfield	12,774	14,363	15,660	16,570	17,390	18,110	19,900	21,800	23,600
Plainville	16,401	17,392	17,790	17,950	17,900	17,690	18,100	18,600	19,000
Plymouth	10,732	11,822	12,290	12,540	12,750	12,850	13,600	14,300	15,000
Pomfret	2,775	3,102	3,050	3,050	3,000	2,950	3,000	3,000	3,100
Portland	8,383	8,418	8,370	8,270	8,110	7,860	7,700	7,500	7,400
Preston	4,644	5,006	5,500	5,680	5,770	5,770	6,200	6,600	7,000
Prospect	6,807	7,775	8,390	8,650	8,860	8,910	9,600	10,400	11,100
Putnam	8,580	9,031	9,030	9,030	8,980	8,870	9,000	9,000	9,100

TABLE 2 (cont)

CONNECTICUT INTERIM LONG RANGE POPULATION PROJECTIONS

Town Name	Census Counts		OPM Interim Population Projections				Long Range Projections		
	1980	1990	1995	2000	2005	2010	2020	2030	2040
Redding	7,272	7,927	8,690	8,980	9,120	9,120	9,800	10,500	11,100
Ridgefield	20,120	20,919	21,690	21,990	21,840	21,600	22,100	22,700	23,300
Rocky Hill	14,559	16,554	17,170	17,430	17,530	17,480	18,400	19,400	20,300
Roxbury	1,468	1,825	2,060	2,150	2,250	2,290	2,600	2,900	3,100
Salem	2,335	3,310	3,680	3,940	4,150	4,310	5,000	5,600	6,300
Salisbury	3,896	4,090	4,190	4,190	4,140	4,140	4,200	4,300	4,400
Scotland	1,072	1,215	1,340	1,470	1,510	1,550	1,700	1,900	2,100
Seymour	13,434	14,288	14,700	14,900	14,850	14,700	15,100	15,600	16,000
Sharon	2,623	2,928	2,980	2,980	2,930	2,880	3,000	3,000	3,100
Shelton	31,314	35,418	38,100	39,350	40,160	40,550	43,700	46,900	50,100
Sherman	2,281	2,809	3,010	3,160	3,210	3,260	3,600	3,900	4,200
Simsbury	21,161	22,023	22,680	22,880	22,830	22,730	23,300	23,800	24,400
Somers	8,473	9,108	9,010	9,010	8,900	8,740	8,800	8,900	8,900
South Windsor	17,198	22,090	25,220	26,800	27,830	28,540	32,400	36,300	40,200
Southbury	14,156	15,818	17,250	17,860	18,460	19,070	20,700	22,400	24,100
Southington	36,879	38,518	40,220	41,150	41,580	41,490	43,200	44,900	46,500
Sprague	2,996	3,008	2,910	2,910	2,910	2,910	2,900	2,800	2,800
Stafford	9,268	11,091	11,420	11,800	12,080	12,410	13,400	14,400	15,400
Stamford	102,453	108,056	110,500	112,940	113,610	114,280	118,300	122,300	126,400
Sterling	1,791	2,357	2,690	2,850	3,070	3,230	3,700	4,200	4,700
Stonington	16,220	16,919	19,410	20,580	21,600	22,450	24,700	27,000	29,300
Stratford	50,541	49,389	48,760	47,770	46,400	44,980	43,100	41,300	39,500
Suffield	9,294	11,427	12,950	13,640	14,230	14,780	16,600	18,500	20,400
Thomaston	6,276	6,947	7,210	7,370	7,470	7,520	7,900	8,400	8,800
Thompson	8,141	8,668	9,090	9,360	9,590	9,830	10,400	11,000	11,600
Tolland	9,694	11,001	12,150	12,780	13,020	13,110	14,300	15,500	16,700
Torrington	30,987	33,687	34,900	36,110	36,460	36,800	38,800	40,800	42,700
Trumbull	32,989	32,016	31,700	31,100	30,100	29,000	27,700	26,400	25,100
Union	546	612	660	660	710	710	800	800	900

TABLE 2 (cont)

CONNECTICUT INTERIM LONG RANGE POPULATION PROJECTIONS

Town Name	Census Counts		OPM Interim Population Projections				Long Range Projections		
	1980	1990	1995	2000	2005	2010	2020	2030	2040
Vernon	27,974	29,841	29,780	29,780	29,620	29,300	29,700	30,100	30,400
Voluntown	1,637	2,113	2,620	2,900	3,170	3,490	4,100	4,800	5,400
Wallingford	37,274	40,822	43,230	44,260	44,940	45,280	48,000	50,800	53,500
Warren	1,027	1,226	1,230	1,170	1,170	1,170	1,200	1,200	1,300
Washington	3,657	3,905	4,090	4,140	4,190	4,190	4,400	4,600	4,700
Waterbury	103,266	108,961	113,050	115,210	117,120	119,240	124,600	130,000	135,400
Waterford	17,843	17,930	18,480	18,480	18,330	18,080	18,200	18,300	18,500
Watertown	19,489	20,456	21,050	21,340	21,240	20,950	21,500	22,000	22,600
West Hartford	61,301	60,110	61,130	60,980	60,330	59,530	59,100	58,700	58,300
West Haven	53,184	54,021	55,260	56,070	56,650	57,130	58,500	59,900	61,400
Westbrook	5,216	5,414	5,510	5,510	5,460	5,370	5,400	5,500	5,500
Weston	8,284	8,648	10,450	11,250	11,830	12,210	13,700	15,200	16,600
Westport	25,290	24,410	24,400	24,050	23,350	22,460	21,600	20,700	19,800
Wethersfield	26,013	25,651	25,810	25,270	24,380	23,340	22,500	21,700	20,800
Willington	4,694	5,979	6,250	6,420	6,530	6,580	7,200	7,800	8,400
Wilton	15,351	15,989	16,290	16,190	15,790	15,430	15,500	15,500	15,500
Winchester	10,841	11,524	11,630	11,630	11,570	11,570	11,800	12,000	12,200
Windham	21,062	22,039	22,460	22,880	23,000	23,120	23,800	24,500	25,200
Windsor	25,204	27,817	29,450	30,110	30,470	30,730	32,600	34,500	36,400
Windsor Locks	12,190	12,358	12,190	11,980	11,550	11,010	10,600	10,200	9,800
Wolcott	13,008	13,700	14,590	14,930	15,130	15,130	15,900	16,700	17,400
Woodbridge	7,761	7,924	8,280	8,280	8,230	8,080	8,200	8,300	8,500
Woodbury	6,942	8,131	8,380	8,480	8,530	8,530	9,000	9,500	10,000
Woodstock	5,117	6,008	6,630	6,940	7,150	7,460	8,200	9,000	9,800

TABLE 2 (cont)

CONNECTICUT INTERIM LONG RANGE POPULATION PROJECTIONS,

Town Name	Census Counts		OPM Interim Population Projections				Long Range Projections		
	1980	1990	1995	2000	2005	2010	2020	2030	2040
PLANNING REGIONS									
CT River Estuary	49,795	54,684	57,790	59,150	59,870	60,500	64,100	67,800	71,400
Capitol	668,479	709,404	731,120	745,350	753,860	760,020	791,100	822,100	853,200
Central CT	216,003	227,676	231,570	233,320	233,180	231,340	236,500	241,700	246,800
Central Naugatuck	237,385	261,081	275,770	282,960	288,340	292,320	311,700	330,500	349,200
Greater Bridgeport	300,897	299,708	299,380	297,190	293,590	289,360	285,600	281,900	278,200
Housatonic Valley	170,369	187,867	198,170	204,040	207,460	209,770	223,200	236,600	250,100
Litchfield Hills	70,539	77,601	81,540	84,080	85,100	85,970	91,200	96,500	101,800
Midstate	87,203	96,996	100,560	102,930	103,890	104,390	110,100	115,800	121,500
Northeastern CT	63,842	71,880	76,360	79,170	81,590	83,860	90,600	97,300	104,000
Northwestern CT	20,651	22,647	23,620	23,800	23,890	23,930	25,000	26,100	27,200
South Central CT	514,413	536,853	553,800	563,280	569,250	573,520	594,000	614,400	634,900
South Western	325,546	329,935	334,420	336,350	333,080	328,010	329,500	331,000	332,500
Southeastern CT	225,666	240,432	251,630	257,560	261,850	264,550	278,000	291,400	304,900
Valley	76,133	80,308	82,190	82,840	82,590	81,820	83,800	85,700	87,700
Windham	70,841	78,341	83,580	86,650	89,180	91,460	98,500	105,500	112,500
Undefined	9,814	11,703	12,080	12,460	12,790	13,110	14,200	15,200	16,300
STATE TOTAL	3,107,576	3,287,116	3,393,570	3,451,120	3,479,500	3,494,530	3,627,000	3,759,600	3,892,100

only addresses the effects of drought conditions which could occur at any time in the future. Modifications in the operational procedures at Mansfield Hollow Lake would provide storage for water supply purposes only when drought conditions exist and not to meet normal water supply demands at some future date.

c. Eastern Connecticut Water Suppliers. Information pertaining to the larger water suppliers in eastern Connecticut are presented in table 1. The data for each water supplier includes the communities served, estimated population served within each community, source of supply (surface or ground), water production in million gallons during 1980, and the estimated safe yield of each source. An analysis as to whether existing sources can provide adequate supplies during drought conditions was not performed. The information has been accumulated to present a summary of existing water conditions pertaining to major water suppliers in the three eastern Connecticut counties.

d. Population Projections. Projections for various towns in Connecticut are presented in table 2 to show the populations in each community potentially affected by a prolonged dry period. The projections were provided by the State of Connecticut, Office of Policy and Management. This information is presented to indicate potential future growth in Connecticut.

7. SPONSOR

a. General. In an effort to make the Drought Contingency Plans fully implementable it is required to identify a local sponsor. If a local sponsor cannot be found, then the plan will be considered inactive and drought storage at the Corps Dam will not be studied further. The approach is for a State to enter into a contract with the Secretary of the Army (or his representative) and agree to act as wholesaler for all water requirements of individual users. This places local governments in a position to help their citizens during difficult times and minimize potential problems that could arise if the Secretary of the Army were to determine who was entitled to shares of drought emergency water, based on assessments of local needs. The sponsor is required to express an interest in utilizing short term storage at the Corps reservoir for emergency water supply and/or other instream flow requirements. By expressing interest, the sponsor will be required to enter into an emergency water supply contract specifying the potential water supply available and costs associated with emergency water supply releases from the Corps project.

b. Mansfield Hollow Sponsor. In accordance with a letter dated 12 June 1991, the State of Connecticut, Department of Health Services (DOHS) has identified themselves as the lead Agency to act as sponsor for the Mansfield Hollow Drought Contingency Plan. A copy of the letter, as well as the Draft Emergency Drought Contingency Water Supply Contract, are presented in appendix D.

During discussions with DOHS it was determined that the primary user of drought storage at Mansfield Hollow Lake would most likely be the Willimantic Water Works, located just downstream of the project. The Willimantic Water Works supply system has a current demand of about 2.5 MGD (4.0 cfs) and a safe yield of about 8.4 MGD (13.4 cfs). This information was received in 1990 from the Willimantic Water Works and is an update to values in table 1.

c. State and Local Contingency Planning. In the event of a water supply emergency declaration in the area of Mansfield Hollow Lake by the Governor or otherwise according to law, the State of Connecticut would initiate a set of procedures in order to ensure a constant supply of water to the Willimantic Water Works in Windham, CT. Guidance for these procedures is provided in the Water Companies Planning Guidance for Emergency Contingency Plans (December 1990) prepared by the Departments of Environmental Protection (DEP), Health Services (DOHS) and Public Utility Control (DPUC) and the Offices of Consumer Counsel and Policy Management. These regulations require water companies supplying water to one thousand or more persons, or 250 or more consumers, to prepare a water supply plan. One component of the plan is "contingency procedures for public drinking water supply emergencies including emergencies concerning the contamination of water." The Willimantic Water Works is the most likely beneficiary of emergency storage at Mansfield Hollow Lake and has prepared an Emergency Contingency Plan (see appendix D) which presents the following steps of water shortage severity.

1. Alert
2. Advisory
3. Emergency - Phase I
4. Emergency - Phase II
5. Emergency - Phase III

Emergency Phase I would be activated by a declaration of water supply emergency and coincides with Phase II - Drought Emergency described below in paragraph 8e(2).

The Willimantic Water Works has the opportunity to notify the DOHS of slower developing water shortages triggered by low rainfall (e.g., through its monthly reports or more immediate water shortages through 24 hour per day telephone service with DOHS).

8. PROPOSED ASSISTANCE PLAN

a. General. There are several authorities providing use of reservoir storage for water supply at Corps of Engineers projects. These vary from provisions of water supply storage as a major purpose in new projects to the discretionary authority to provide emergency supplies to local communities in need. Under authority of ER 1110-2-1941 New England Division is directed to determine the short term water supply capability of their existing reservoirs that would be functional under existing authorities. Congressional authorization is not required to add municipal and industrial water supply if the related revisions in regulation would not significantly affect operation of the project for the originally authorized purposes.

b. Mansfield Hollow Plan

(1) There is no storage allocated for water supply at Mansfield Hollow Lake; therefore, the only existing drought assistance capability would be through increased flexibility of regulation and short term use of project authorized storage. We determined that the Mansfield Hollow pool can be raised to elevation 213.0 feet NGVD to provide short term drought emergency assistance without compromising the flood control purpose of the project nor negatively impacting the recreational aspects of the project. A pool of 213.0 feet NGVD, represents a volume of about 680 acre-feet (221 million gallons) over the summer recreation pool or 2,480 acre-feet (808 million gallons) over the winter pool.

(2) The extent of Corps assistance is limited to the time of year drought conditions exist, as well as availability of sufficient inflow to the reservoir. Anticipating that there would be sufficient inflow as well as enough forewarning to fill the reservoir in the May to June timeframe, the Corps should be in a position to render assistance during the proceeding historic low flow summer months (July to October timeframe). Based on the May to June low flow duration analysis, it was determined that during a 10-year frequency drought there would be sufficient riverflow to fill the reservoir from the recreation pool to the drought pool in about a 20-day period. During this filling period, a minimum release rate from the dam of about 40 cfs (7Q10 low flow for

the May to June timeframe) or inflow, whichever is less, would be maintained whenever possible. However, if there is insufficient inflow available or if conditions exist within the watershed that would prevent the Corps from storing water to the drought pool level, the amount of assistance from the Corps may be limited.

(3) Once the water was stored at the drought pool level and a "declared" drought emergency existed, a water supply contract would be signed by the Corps and the State of Connecticut and emergency water supply releases would be made from the project. We anticipate that these releases would be in addition to passing all inflow through the dam and would occur during the July to October timeframe and continue until the pool level was lowered to the recreation pool. At that time New England Division would decide whether additional releases could be made to draw down the reservoir to the winter pool. If continued drawdown is needed New England Division will once again decide if drawdown into the winter pool is feasible.

(4) If assistance is requested beyond the May to June timeframe, the period to fill as well as the risk associated with flood protection would have to be decided by New England Division prior to initiation of the drought storage operation. We assume that some variation of the drought procedure mentioned above would be possible to render assistance regardless of the time of year. Minimum release rates (generally equal to the seasonal 7Q10), as well as drought pool filling durations would vary, depending on the season of the year when assistance is needed. Drought contingency storage versus flow duration at Mansfield Hollow Lake are shown graphically on plate 3.

c. Water Shortage Indicators. The Reservoir Control Center (RCC) of the New England Division will keep abreast of current hydrologic as well as climatologic data at all Corps projects in an effort to aid in recognition of the onset of dry or drought conditions. A series of guide curves have been developed as a tool in this recognition process. Curves such as rainfall-duration-frequency and minimum-surface runoff-frequency were developed for various index stations throughout New England. Selected index stations selected were based on proximity to Corps reservoirs, period of record, and reliability of data. The guide curves were developed and compared with historic drought data as a way to "track" current observed conditions with comparable historic conditions. Appendix A presents the guide curves with an explanation on their development and use. Also presented in appendix A is the Palmer Drought Severity Index (PDSI)

classification chart with available New England historic index levels.

As data is monitored by RCC, it will be used with these guide curves as well as supplemental information received from various Federal and State Agencies prior to decisions of storing emergency drought water at Mansfield Hollow Lake.

d. Emergency Operations Center (EOC). As RCC collects and monitors climatologic and hydrologic data associated with dry or drought conditions, the New England Division EOC will initiate discussions with in-house Corps elements as well as other respective Federal and State Agencies to review possible drought concerns and for Corps action. For Mansfield Hollow Lake the lead State Agency coordination is:

Department of Health Services
Water Supplies Section
150 Washington Avenue
Hartford, Connecticut 06106
Telephone 203-566-1253

All decisions regarding Corps action during dry or drought conditions will be made by the EOC.

e. Phases of Drought Assistance. Drought assistance from Mansfield Hollow Lake will be in two phases. Phase I will be during "drought watch" conditions existing within the Mansfield Hollow region of Connecticut and Phase II - drought emergency declared by the State of Connecticut. Phases I and II are explained below.

(1) Phase I - Drought Watch. This is the initial phase of implementation of drought assistance. The following conditions and actions will take place during this phase:

(a) Initial indications conclude that a drought condition is developing within this region of Connecticut. Close coordination between New England Division and other Federal and State agencies, in addition to coordinated efforts within the EOC, have identified that a drought condition is beginning (refer to appendix A for climatologic and hydrologic guide curves of precipitation as well as surface runoff data). This coordination will insure that actions being taken, as well as all decisions, are targeted to meet specific needs and not to react prematurely.

(b) Pending coordination with the Connecticut Department of Health Services and their subsequent concurrence with the Corps to store water at Mansfield Hollow Lake,

and subject to availability of inflow, Mansfield Hollow reservoir will be filled to elevation 213.0 feet NGVD.

(c) The water will be stored at this level and outflow will be set equal to inflow in order to maintain the pool at a constant level. This pool will be maintained until the Connecticut Department of Health Services formally requests emergency water supply releases be made. This will take place during the drought emergency phase. Release rates would then be equivalent to inflow plus water supply demand (as requested by DOHS).

(2) Phase II - Drought Emergency

(a) A drought emergency declaration has been declared by the Governor of Connecticut, or otherwise according to law, and issued by the Connecticut Department of Health Services.

(b) Department of Health Services contacts New England Division, requesting that releases, of a specific amount, be made.

(c) Division Engineer convenes a meeting with Emergency Operations Center to discuss request.

(d) If emergency water supply releases are to be made, a target release rate will be determined by New England Division. This rate will include the natural inflow to the reservoir as well as the water supply release rate requested by DOHS. Prior to any releases, the water supply contract will be signed by the Corps and the State of Connecticut.

(e) Drawdown of the pool will continue until lowered to the recreation level. At that time New England Division will decide if continued releases can be made to drawdown the recreation pool to the level of the winter pool as well as the feasibility of drawing down into the winter pool (during this operation any recovery of water supply storage will be made if conditions permit).

f. Compensation for Use of Storage. As directed in ER 1105-2-100 dated 28 December 1990, compensation must be received for all "emergency drought releases." This compensation will be at least equal to a proper share of annual joint use O&M costs and major replacement expenses plus revenues foregone as well as other costs directly attributable to making releases. For Mansfield Hollow, an approximate annual cost of \$645 has been determined for the

release of approximately 680 acre-feet of drought assistance water based on 1991 dollars. Appendix B presents the Economic Assessment of Drought Contingency Water Supply Pricing at Mansfield Hollow. Said costs are also identified in the draft water supply contract in appendix D.

9. DISCUSSION OF IMPACTS

a. General. Any action resulting in a temporary change of reservoir storage volumes will have impacts on authorized project purposes, which must be evaluated as part of the drought storage implementation plan. At Mansfield Hollow Lake, the drought contingency plan is one component of the existing, approved total water control plan. Presented below is a cursory evaluation of impacts resulting from drought contingency storage on flood control and recreation purposes of the project. Effects on environmental as well as historic and archaeological resources will be addressed when an updated Environmental Assessment (EA) for the complete operation of the project has been completed. For purposes of this drought contingency plan, the existing EA, prepared in April 1977, supporting the approved water control plan, will be used.

b. Flood Control. A review of regulation procedures at Mansfield Hollow Lake was undertaken to determine the volume of water that could be made available for emergency drought contingency purposes. The water would be stored by temporarily utilizing existing flood control storage. We recognize that major floods occur in every season of the year and any use of flood control storage would be continually monitored to insure there would be no adverse impacts on downstream flood protection.

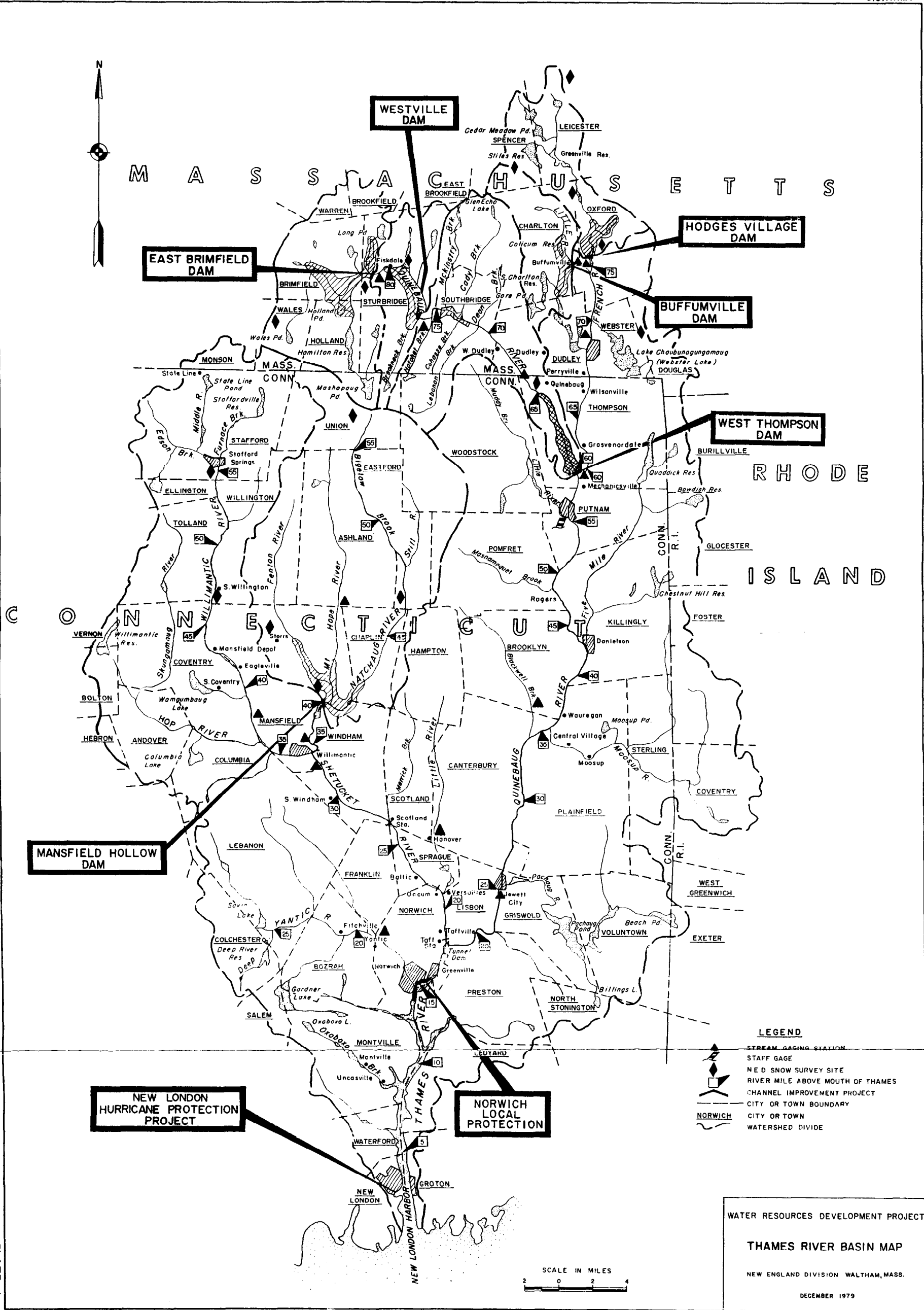
At Mansfield Hollow Lake, the maximum pool elevation for drought contingency storage has been estimated to be 213.0 feet NGVD, representing an infringement on flood control storage of about 0.1 inch, from the total storage capacity of 5.8 inches of runoff, from the 159 square mile upstream drainage area. At an elevation of approximately 213.0 feet NGVD, water can be stored without significantly affecting flood control capability or other regulation activities.

c. Recreation. No adverse impact. The culvert under Basset Bridge Road that separates the lake into two parts will still allow boats to pass through at a reservoir stage of 18 feet (elevation 213 feet NGVD).

d. Water Quality. Drought contingency storage at Mansfield Hollow Lake would raise the pool 1.5 feet above the 211.5 feet NGVD recreation pool elevation to 213.0 feet NGVD, an increase in depth from 16.5 to 18.0 feet. This increase would only occur during a drought period. Water quality effects that could result from drought storage include decreases in dissolved oxygen, increases in water temperature, iron, manganese, phosphorus, ammonia, color, and suspended solids. These increases would be minor and are not expected to threaten aquatic life or human health. Although the lake would be subject to a greater potential for occurrence of localized algae blooms, severe algae problems are not anticipated and trophic status of the lake should remain unchanged. Effects of drought storage operations on downstream water quality are expected to be minimal as well. The waters of Mansfield Hollow Lake would require standard treatment processes for drinking water supply, thus the processes currently used to treat the Willimantic Reservoir water supply, located just downstream of Mansfield Hollow dam, should not have to be upgraded as a result of drought storage. No treatment would be necessary for firefighting, irrigation, and most industrial uses in the event of drought storage implementation. Appendix C presents a comprehensive water quality evaluation regarding drought contingency storage at Mansfield Hollow Lake.

10. CONCLUSIONS

A drought contingency plan was developed for Mansfield Hollow Lake that would be responsive to public needs during drought situations. This plan would permit encroachment on flood control storage to elevation 213 feet NGVD, providing an emergency water supply contingency of about 680 acre-feet (221 million gallons) over the summer recreational pool or in times of extreme emergency a potential 2,480 acre-feet (808 million gallons) over the winter pool. The State of Connecticut has agreed to sponsor the implementation of this plan during times of drought emergency.



WATER RESOURCES DEVELOPMENT PROJECT

THAMES RIVER BASIN MAP

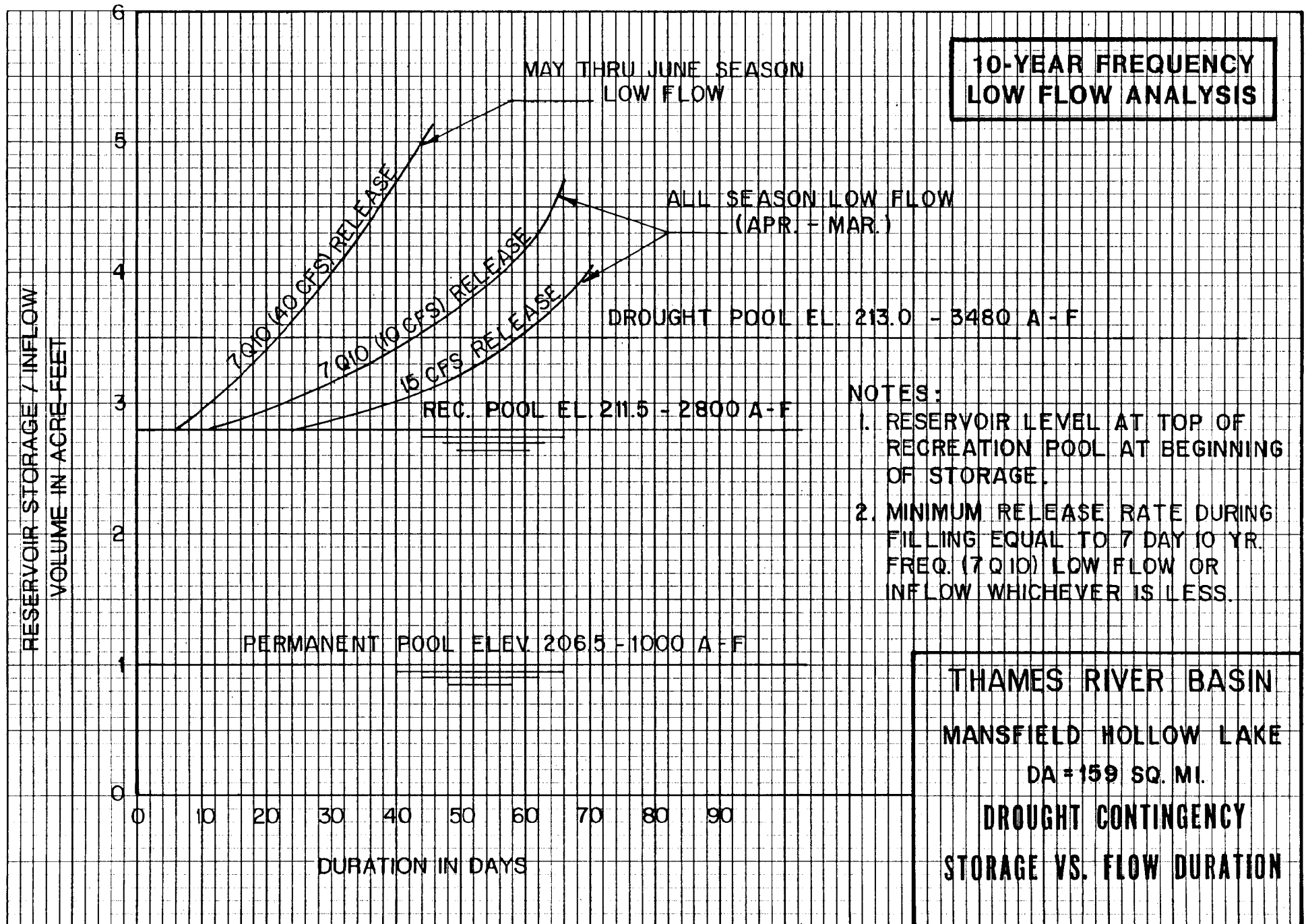
NEW ENGLAND DIVISION WALTHAM, MASS.

DECEMBER 1979

MANSFIELD HOLLOW RESERVOIR
AREA AND CAPACITY
DRAINAGE AREA: 159 SQ. MI.

<u>Elev.</u> <u>(msl)</u>	<u>Stage</u> <u>(ft.)</u>	<u>Area</u> <u>(acres)</u>	<u>Capacity</u>		<u>Elev.</u> <u>(msl)</u>	<u>Stage</u> <u>(ft.)</u>	<u>Area</u> <u>(acres)</u>	<u>Capacity</u>	
			<u>(ac.ft.)</u>	<u>(inches)</u>				<u>(ac.ft.)</u>	<u>(inches)</u>
<u>Recreation Storage</u>					<u>Flood Control Storage (cont.)</u>				
195	0	0	0	0	226	31	810	9,200	1.10
196	1	0	0	0	227	32	835	10,000	1.18
197	2	5	0	0	228	33	855	10,800	1.27
198	3	8	0	0	229	34	880	11,700	1.38
199	4	18	0	0	230	35	900	12,600	1.49
200	5	25	20	0	231	36	925	13,500	1.59
201	6	70	55	0.01	232	37	955	14,450	1.70
202	7	100	135	0.02	233	38	980	15,400	1.82
203	8	130	250	0.03	234	39	1,015	16,400	1.93
204	9	165	400	0.05	235	40	1,040	17,450	2.05
205	10	200	580	0.07	236	41	1,070	18,500	2.18
206	11	240	800	0.09	237	42	1,095	19,600	2.31
207	12	280	1,060	0.12	238	43	1,125	20,700	2.44
208	13	325	1,365	0.16	239	44	1,160	21,800	2.57
209	14	370	1,715	0.20	240	45	1,190	23,000	2.71
210	15	415	2,120	0.25	241	46	1,225	24,200	2.85
211	16	440	2,545	0.30	242	47	1,260	25,450	3.00
211.5	16.5	450	2,800	0.33	243	48	1,295	26,700	3.15
<u>Flood Control Storage</u>					244	49	1,330	28,000	3.30
211.5	16.5	450	0	0	245	50	1,360	29,400	3.47
212	17	465	200	0.02	246	51	1,400	30,800	3.63
213	18	490	680	0.08	247	52	1,450	32,200	3.80
214	19	515	1,180	0.14	248	53	1,490	33,700	3.97
215	20	540	1,710	0.20	249	54	1,530	35,200	4.15
216	21	565	2,200	0.26	250	55	1,580	36,700	4.33
217	22	595	2,840	0.33	251	56	1,625	38,300	4.52
218	23	620	3,450	0.41	252	57	1,670	40,000	4.71
219	24	650	4,080	0.48	253	58	1,710	41,600	4.91
220	25	675	4,750	0.56	254	59	1,750	43,400	5.12
221	26	690	5,430	0.64	255	60	1,790	45,400	5.35
222	27	710	6,130	0.72	256	61	1,840	47,200	5.57
223	28	740	6,850	0.81	257	62	1,880	49,200	5.80
224	29	760	7,600	0.90					
225	30	785	8,400	0.99					

NOTES: Gate Sill Elevation = 195
 Spillway Crest Elevation = 257
 1" Runoff = 8,480 acre-feet



APPENDIX A

CLIMATOLOGIC AND HYDROLOGIC INDICATORS

APPENDIX A
DROUGHT CONTINGENCY PLAN
CLIMATOLOGIC AND HYDROLOGIC INDICATORS

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DROUGHT CONTINGENCY PLAN CLIMATOLOGIC AND HYDROLOGIC INDICATORS

1. INTRODUCTION

This appendix is presented to supplement the developed Drought Contingency Plan with climatological as well as hydrological data that are useful towards identifying and recognizing periods of dry or drought conditions. The analyses presented is not intended to predict a drought, as most drought predicting measures are not considered very accurate or promising. It is however, intended to aid in recognizing the onset of water shortage conditions in an effort to mitigate their impacts prior to severe or emergency conditions prevailing. It is most beneficial to recognize the beginning of a drought rather than to initiate action after the drought's effect become apparent.

The data presented is in the form of "guide curves" and do not serve the purpose of a single "trigger" in which emergency drought storage at Corps reservoirs would be initiated. As stated in the main text of the Drought Contingency Plan, NED's decision to store emergency water supply would be based on a combination of the guide curves as well as information received from various Federal and State agencies.

The data presented is an attempt to show regional indicators of dry or drought periods. While specific index stations were used in developing the guide curves, their use is not to be restricted to that station only. Their application is considered to represent generalized conditions in areas within the region.

Indicators such as rainfall-duration-frequency and minimum surface runoff-duration frequency were developed for various index stations within New England. Index stations selected were based on proximity to Corps drought contingency candidate reservoirs, period of record and reliability of data. The guide curves were developed and compared with historic drought data as a way to "track" current observed conditions with comparable historic conditions. Also presented is the Palmer Drought Severity Index (PDSI) classification chart with available New England historic drought index levels indicated.

2. DROUGHTS

a. General. Hydrologically, drought is defined as a prolonged period of precipitation deficiency which seriously affects riverflow as well as surface and groundwater supplies. The duration, magnitude, severity, frequency and areal extent have been identified as five common characteristics of drought. These characteristics are applicable to drought whether measured by

precipitation, streamflow, reservoir levels or by the Palmer index.

b. History. Drought history in New England before 1900 is rather limited. Periods of precipitation deficiencies were experienced, however, records of runoff deficiency are relatively non-existent. Since the establishment of streamflow gaging stations, low flow periods and drought conditions have been observed throughout the New England river basins at various times. Serious droughts occurred within New England during the periods 1924-1927; 1929-1933 and 1961-1967.

c. Drought of Record. The drought of 1961 to 1967 was the longest and most severe in the history of the New England region. This was the severest in nearly 170 years of precipitation records in Boston, Massachusetts. The 1960's drought followed a period of above normal precipitation which contributed to relaxation on the part of cities and towns during what was really a period of rapidly increasing water demand. In addition, a considerable number of water facilities failed since most had been designed to meet a repetition of the less severe drought of the 1930's.

During the period 1963 through 1966, the cumulative precipitation deficiencies (i.e. total amount below normal) varied from about 40 to 60 inches throughout New England, which is equivalent to 1 to 1.3 years of normal rainfall.

The accumulative deficiency in the average runoff for water years 1962 to 1966 varied from about 25 to 50 inches throughout New England, equivalent to about 1 to 2 years of average annual runoff.

3. CLIMATOLOGIC AND HYDROLOGIC ANALYSIS

a. General. Streamflow, reservoir levels, ground water levels, soil moisture, precipitation and the Palmer Drought Severity Index are some of the indicators used by drought managers for early detection as well as continued tracking of a drought. This analysis focused on three of these indicators: rainfall; runoff and the Palmer Index. Rainfall and runoff were selected due to the large magnitude of available historic as well as current data. The Palmer Index was selected primarily due to its wide acceptance as a reliable drought indicator. While many more parameters are used in the drought identification process, it is believed that for purposes of the Drought Contingency Plans the parameters selected and the analysis performed offer a reasonable approach to drought management at NED reservoirs.

b. Climatological Data. Rainfall frequencies for 1, 3, 6 and 12 month durations were developed for various index stations. The curves were developed using the period of record monthly rainfall data at each index station. Accumulative tabulations were made for 1, 3, 6 and 12 consecutive months, assigning Weibull plotting positions and fitting the curves through the data. Index stations

selected, with their corresponding periods of record, as well as the mean, maximum and minimum monthly rainfall, are shown in tables 1 through 3. The computed frequency curves are graphically shown on plates 1 through 3. Historic data, where available, was plotted on the 3, 6 and 12 month duration curves. The historic data was presented to allow comparison with any current data to that which occurred during historic droughts. This comparative analysis allows for a better understanding of the drought or dry period being experienced and provides for a historical perspective during drought tracking procedures.

Although the 1 and 3 month durations are presented, it is suggested that any drought emergency actions or conclusions not be based solely on the data of these short durations. In the New England region, experience has shown that low rainfall amounts for durations of 1 and 3 months do not necessarily constitute a dry or drought condition. For example: During the winter of 1988/1989 rainfall was historically low for a consecutive 3 month duration, measuring 6.5 inches at Storrs, Ct. Applying this rainfall to the 3 month curve identified the frequency to be about a 16 year drought, tracking somewhere between the historic droughts of 1924-1927 and 1980-1981. However, when the 6 month cumulative rainfall, during the same dry period, computed to be 21.5 inches, was applied to the 6 month curve, the frequency became less critical, equivalent to about a 2 year event. On an annual duration, the total 1989 rainfall amounts were considered at or above normal despite record low 3 month durations. Had drought emergency measures been implemented solely on the 3 month duration data it would have been proven to be premature or unnecessary. It is therefore recommended that although 1 and 3 month rainfall amounts should not be ignored, durations greater than 3 months should always be considered prior to any emergency drought plans being implemented.

c. Hydrologic Data. Streamflow data measured and published by the U.S. Geological Survey was used exclusively in all hydrologic analysis performed as part of this appendix. Since this analysis concerned itself with low streamflows, an attempt was made to identify and use streamflow index stations that are not regulated during periods of low flow. While many New England rivers and streams are regulated, to some extent, by mill pond dams, as well as other run of river type dams, it was assumed that any occasional regulation of low flows on the index stations selected would be considered to be minor and have minimal affect on natural low flow conditions. The mean, maximum and minimum monthly flows for four USGS gaging stations used as index stations in this report are presented in tables 4 through 7.

An annual low flow frequency analysis was made of the historical low flow data for each selected USGS gaging station. Low flows were determined for durations of 1, 3, 14, 30, 60, 90, 183 and 365 consecutive days for each climatological year (1 April

TABLE A-1

PRECIPITATION SUMMARY (INCHES)
STORRS, CONNECTICUT
ELEVATION 650 FT. NGVD
(101 Years of Record)

<u>Month</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
January	3.65	13.79	0.64
February	3.25	7.89	0.37
March	3.94	10.65	0.15
April	3.80	10.94	0.55
May	3.76	9.21	0.33
June	3.33	12.79	0.29
July	4.15	12.15	0.78
August	4.19	14.75	0.47
September	3.84	17.00	0.45
October	3.64	8.82	0.15
November	4.00	9.24	0.47
December	3.84	9.97	0.68
ANNUAL	44.90	66.31	29.16

TABLE A-2

PRECIPITATION SUMMARY (INCHES)
AMHERST, MASSACHUSETTS
ELEVATION 150 FT. NGVD
(64 Years of Record)

<u>Month</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
January	3.11	8.16	0.49
February	2.81	7.58	0.08
March	3.44	8.24	0.24
April	3.61	8.99	0.55
May	3.75	11.95	0.83
June	3.97	10.25	0.72
July	3.74	10.56	0.00
August	3.73	16.10	0.67
September	3.77	14.55	0.94
October	3.17	8.10	0.32
November	3.84	8.65	0.70
December	3.47	8.77	0.58
ANNUAL	42.55	60.25	29.55

TABLE A-3

PRECIPITATION SUMMARY (INCHES)
CONCORD, NEW HAMPSHIRE
ELEVATION 350 FT. NGVD
(69 Years of Record)

<u>Month</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
January	2.69	8.09	0.40
February	2.45	7.77	0.03
March	3.12	10.36	0.55
April	3.11	6.63	0.42
May	3.10	9.52	0.60
June	3.34	10.10	0.64
July	3.38	7.57	0.96
August	3.01	6.88	0.95
September	3.16	10.68	0.41
October	2.85	8.78	0.05
November	3.73	7.59	0.50
December	4.56	10.34	0.58
ANNUAL	38.26	54.29	24.17

TABLE A-4

MONTHLY STREAM FLOW
QUINEBAUG RIVER AT JEWETT CITY, CT
DRAINAGE AREA = 713 Sq. Miles
(1919 - 1990)

<u>Month</u>	<u>Mean</u>		<u>Maximum</u>		<u>Minimum</u>	
	cfs	inches	cfs	inches	cfs	inches
January	1566	2.52	5694	9.18	219	0.35
February	1664	2.19	3919	5.16	473	0.62
March	2530	4.08	6930	11.17	1220	1.97
April	2436	3.68	5519	8.33	854	1.29
May	1534	2.47	2842	4.58	620	1.00
June	1033	1.56	4758	7.18	262	0.40
July	578	0.93	4110	6.63	138	0.22
August	498	0.80	3918	6.32	98	0.16
September	532	0.80	3502	5.28	97	0.15
October	630	1.02	3279	5.29	132	0.21
November	1066	1.61	3443	5.19	189	0.29
December	1434	2.31	4125	6.65	281	0.45
ANNUAL	1293	23.54	2015	38.24	598	11.35

TABLE A-5

MONTHLY STREAM FLOW
WEST BRANCH WESTFIELD RIVER
AT HUNTINGTON, MA
DRAINAGE AREA = 94 Sq. Miles
(1935 - 1990)

<u>Month</u>	<u>Mean</u>		<u>Maximum</u>		<u>Minimum</u>	
	cfs	inches	cfs	inches	cfs	inches
January	173	2.12	448	5.49	24	0.29
February	185	2.05	712	7.88	35	0.39
March	369	4.52	1098	13.46	112	1.37
April	503	5.97	1069	12.68	116	1.38
May	257	3.15	761	9.33	76	0.93
June	141	1.67	684	8.11	27	0.32
July	66	0.81	307	3.76	10	0.12
August	57	0.69	632	7.75	9	0.11
September	64	0.76	579	6.87	9	0.11
October	102	1.25	1041	12.76	13	0.16
November	173	2.05	544	6.45	25	0.30
December	195	2.39	664	8.14	40	0.49
ANNUAL	190	27.36	296	42.62	74	10.66

TABLE A-6.

MONTHLY STREAM FLOW
SMITH RIVER NEAR BRISTOL, NH
DRAINAGE AREA = 86 Sq. Miles
(1918 - 1990)

<u>Month</u>	<u>Mean</u>		<u>Maximum</u>		<u>Minimum</u>	
	cfs	inches	cfs	inches	cfs	inches
January	99	1.33	253	3.39	19	0.25
February	99	1.20	578	7.00	21	0.25
March	254	3.41	1242	16.65	30	0.40
April	487	6.33	1077	14.00	183	2.38
May	230	3.08	504	6.76	72	0.97
June	104	1.35	353	4.59	21	0.27
July	52	0.70	387	5.19	9	0.12
August	34	0.46	168	2.25	5	0.07
September	41	0.53	457	5.94	8	0.10
October	68	0.91	267	3.58	9	0.12
November	127	1.65	379	4.93	25	0.33
December	131	1.76	393	5.27	22	0.29
ANNUAL	143	22.57	223	35.19	65	10.26

TABLE A-7

MONTHLY STREAM FLOW
WEST RIVER AT NEWFANE, VT
DRAINAGE AREA = 308 Sq. Miles
(1919 - 1990)

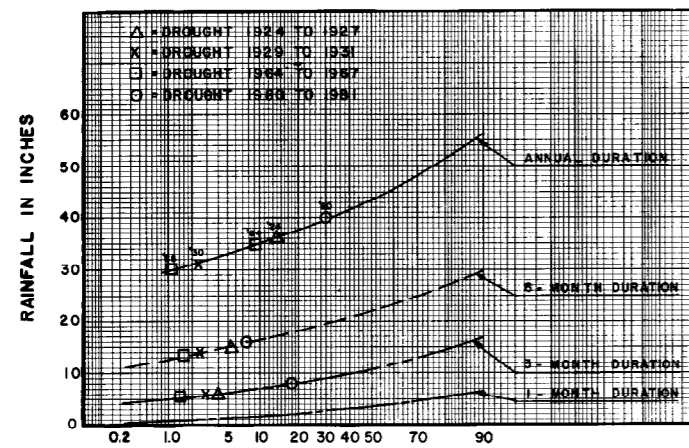
<u>Month</u>	<u>Mean</u>		<u>Maximum</u>		<u>Minimum</u>	
	cfs	inches	cfs	inches	cfs	inches
January	452	1.69	1515	5.67	95	0.36
February	444	1.50	1497	5.06	109	0.37
March	1090	4.08	3712	13.89	184	0.69
April	2199	7.92	4411	15.88	589	2.12
May	1010	3.78	2733	10.23	249	0.93
June	403	1.45	1439	5.18	64	0.23
July	205	0.77	1321	4.94	29	0.11
August	159	0.60	1539	5.76	36	0.13
September	200	0.72	1667	6.00	22	0.08
October	337	1.26	1768	6.61	33	0.12
November	567	2.04	1437	5.17	91	0.33
December	556	2.08	1578	5.91	137	0.51
ANNUAL	636	28.02	1084	47.77	272	11.98

to 31 March) using the USGS "WATSTORE" data storage and retrieval computer system. The annual low flows for each duration were fitted to a Log Pearson Type III distribution. The fitting technique involves transforming annual low flow values to logarithmic values and finding the mean, standard deviation and skew coefficient of the logarithms. The computed low flow frequency duration curves are shown graphically on plates 1 through 3. Historical data, where available, was plotted for each index station. It is noted that low flow duration curves are not shown less than a 30 day period. Within New England, low streamflow data, over a consecutive period of less than 30 days, is considered to be inconclusive when assessing drought conditions.

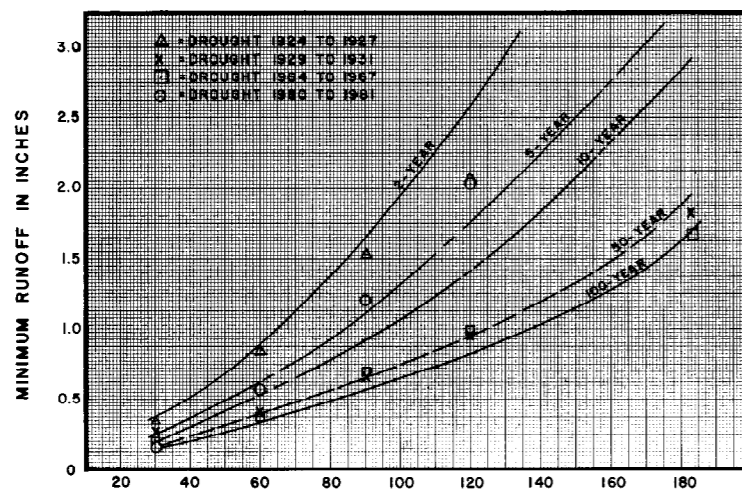
d. Palmer Drought Severity Index (PDSI). The Palmer Drought Severity Index is a widely used indicator of drought conditions. It is published in the following: "Weekly Weather and Crop Bulletin" prepared jointly by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Department of Agriculture (USDA); "Weekly Climate Bulletin" of the NOAA, Climate Analysis Center; and monthly "National Water Conditions" report of the U.S. Geological Survey. The National Climate Center computes the PDSI for all climate divisions in the contiguous United States.

The PDSI is a meteorological index that reflects estimates of departure of soil moisture from normal. Normal moisture conditions are derived from period of record data including monthly averages of evapotranspiration, soil water recharge, runoff and water loss from the soil. The index is standardized so that it has a consistent meaning in different climate areas and from month to month. The classification system translates the numerical value of the index to a descriptive measure of drought or wetness. The dry periods on the index are classified as extreme drought and assigned a numerical value of -4.0. The region on the PDSI graph between extreme drought and near normal conditions was subdivided into three additional drought categories: Severe (PDSI = -3.0): Moderate (PDSI = -2.0); and Mild (PDSI = -1.0). The current PDSI classification system is shown graphically on plates 1 through 3. Also shown on the PDSI graphs are the classifications assigned by others to some historic droughts data that occurred throughout New England.

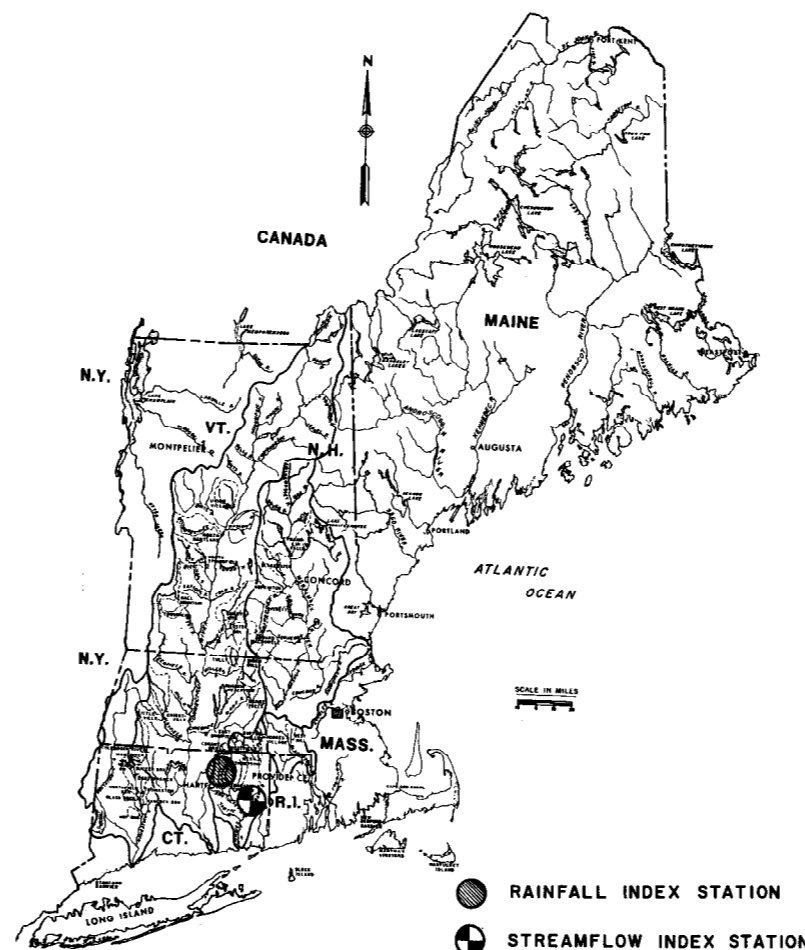
The PDSI is presented as a tool in assessing current wet or dry conditions only and should be used in conjunction with other hydrological and climatological data for effective drought management. The PDSI should not be used for drought planning or hydrologic drought forecasting.



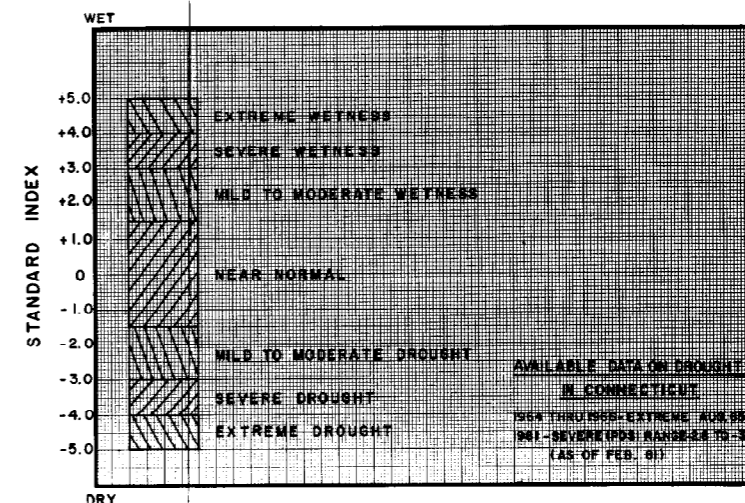
PERCENT CHANCE OF OCCURENCE IN ANY YEAR
RAINFALL DURATION CURVES
 STORRS, CONNECTICUT (EL. = 650.0 FT. N.G.V.D.)
 PERIOD OF RECORD 101 YRS.



MINIMUM RUNOFF-FREQUENCY CURVES
 QUINEBAUG RIVER AT JEWETT CITY, CONNECTICUT
 D.A. = 713 SQ. MI.
 PERIOD OF RECORD 73 YRS.



RAINFALL AND STREAMFLOW LOCATION MAP



PALMER DROUGHT SEVERITY INDEX (PDSI)
 STANDARD CLASSIFICATION INDEX OF WET AND DRY PERIODS

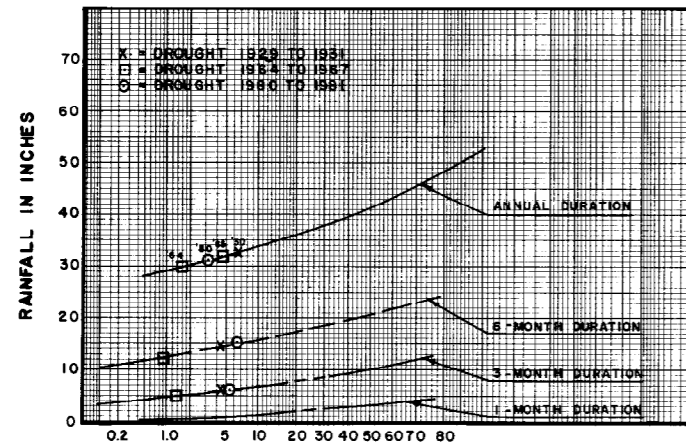
DEPARTMENT OF THE ARMY
 NEW ENGLAND DIVISION
 CORPS OF ENGINEERS
 WALTHAM, MASS.

DROUGHT CONTINGENCY PLAN

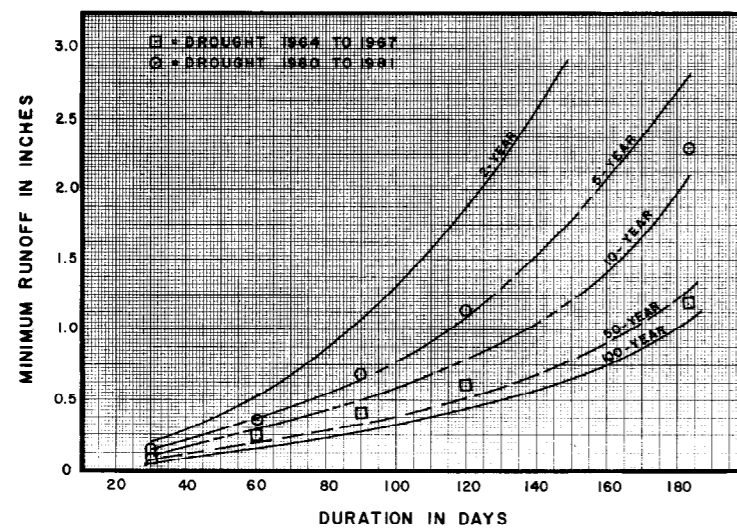
RAINFALL AND RUNOFF

GUIDE CURVES FOR

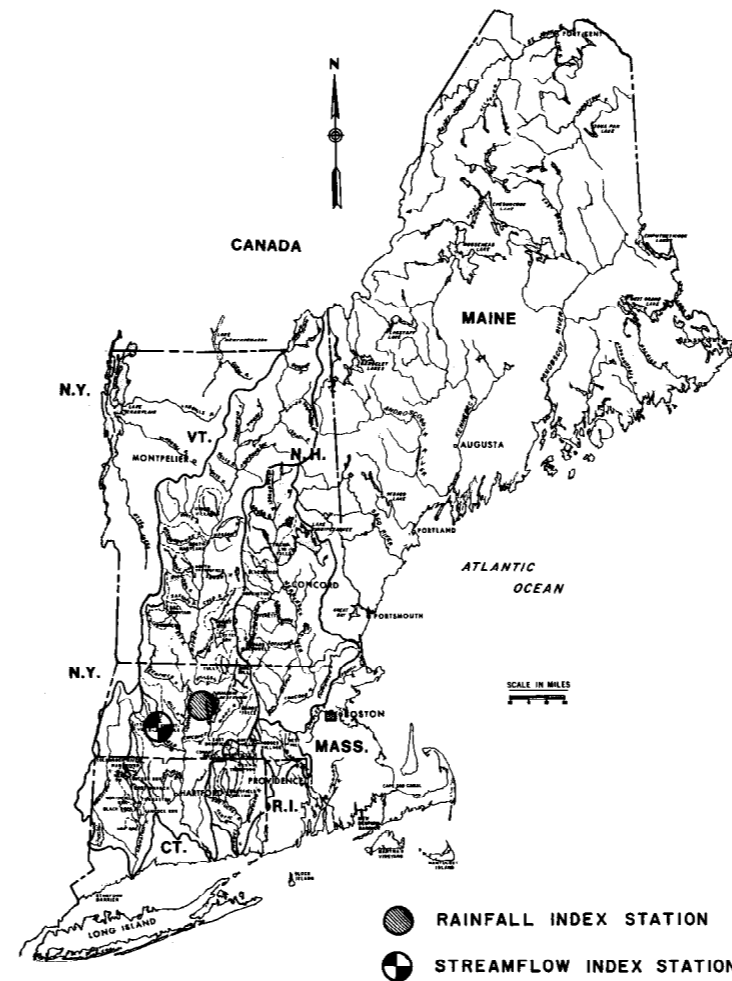
SOUTHERN NEW ENGLAND



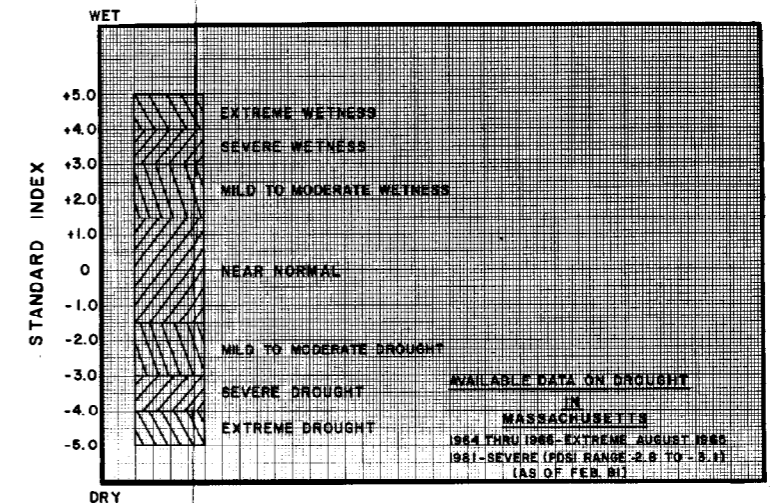
PERCENT CHANCE OF OCURENCE IN ANY GIVEN YEAR
RAINFALL DURATION CURVES
 AMHERST, MASSACHUSETTS (EL. = 150.0 FT. N.G.V.D.)
 PERIOD OF RECORD 64 YRS.



MINIMUM RUNOFF-FREQUENCY CURVES
 WEST BRANCH WESTFIELD RIVER AT
 HUNTINGTON, MASSACHUSETTS
 D.A. = 94 SQ. MI.
 PERIOD OF RECORD 54 YRS.



RAINFALL AND STREAMFLOW LOCATION MAP



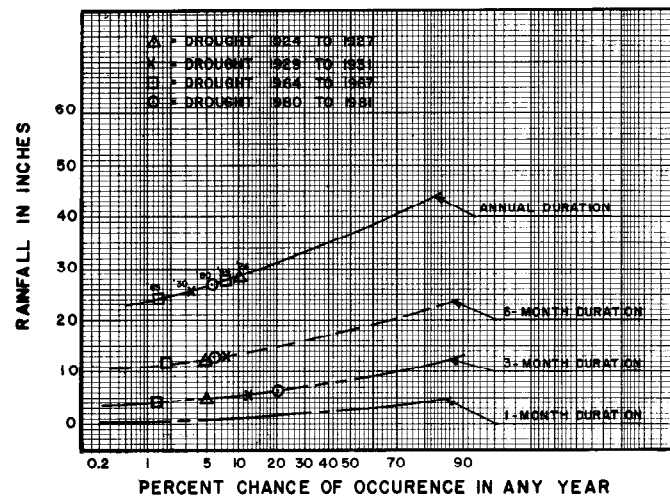
PALMER DROUGHT SEVERITY INDEX (PDSI)
 STANDARD CLASSIFICATION INDEX OF WET AND DRY PERIODS

DEPARTMENT OF THE ARMY
 NEW ENGLAND DIVISION
 CORPS OF ENGINEERS
 WALTHAM, MASS.

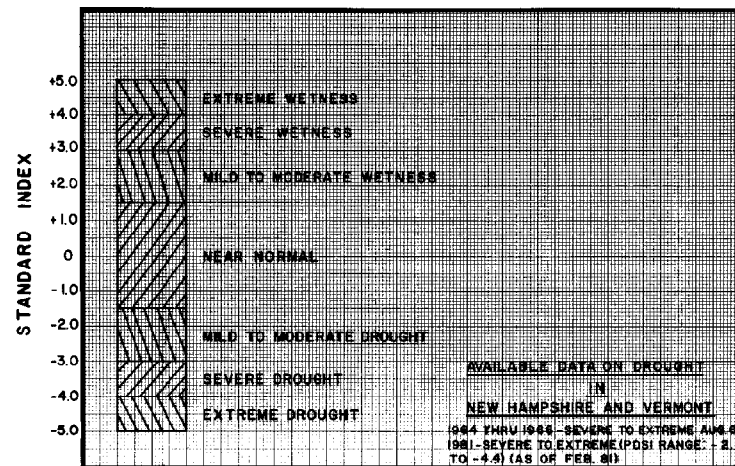
DROUGHT CONTINGENCY PLAN

RAINFALL AND RUNOFF

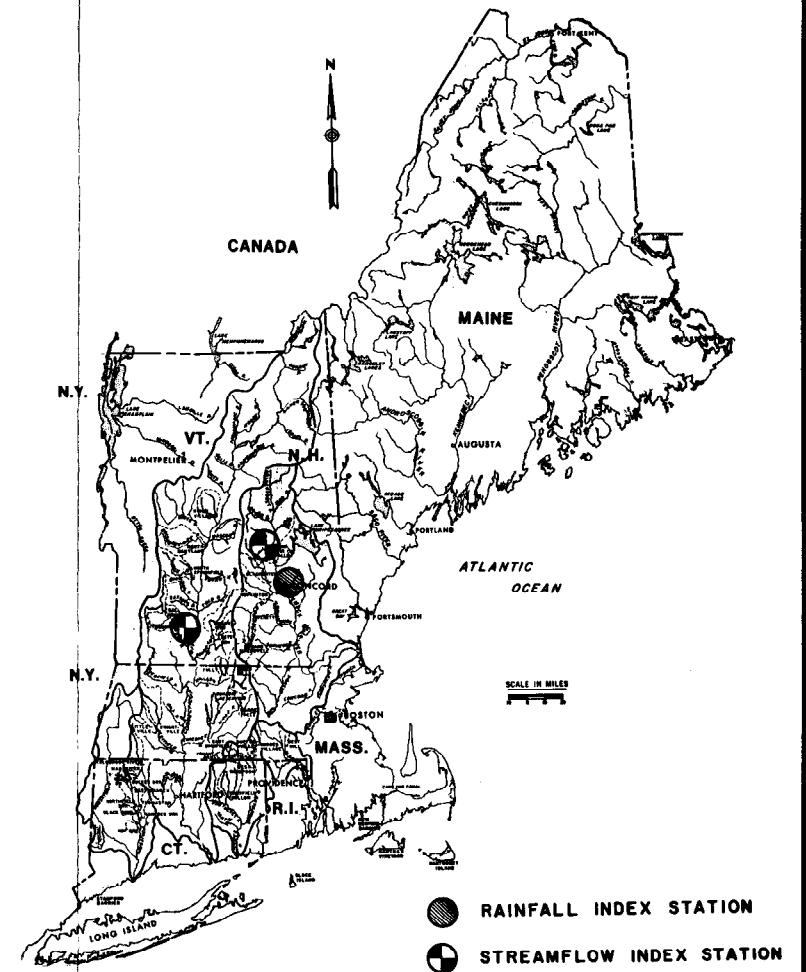
GUIDE CURVES FOR
 MASSACHUSETTS AND SOUTHERN N.H.



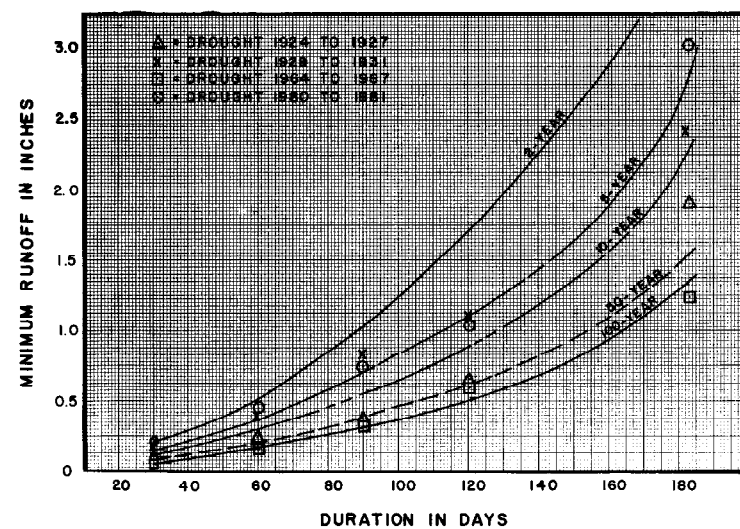
RAINFALL DURATION CURVES
CONCORD, NEW HAMPSHIRE (EL. = 350.0 FT. N.G.V.D.)
PERIOD OF RECORD 69 YRS.



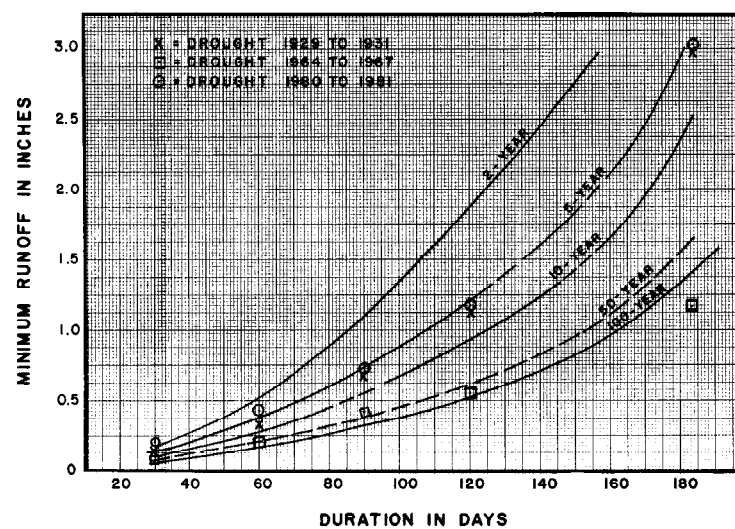
PALMER DROUGHT SEVERITY INDEX (PDSI)
STANDARD CLASSIFICATION INDEX OF WET AND DRY PERIODS



RAINFALL AND STREAMFLOW LOCATION MAP



MINIMUM RUNOFF-FREQUENCY CURVES
SMITH RIVER NEAR BRISTOL, NEW HAMPSHIRE
D.A. = 85.8 SQ. MI.
PERIOD OF RECORD 71 YRS.



MINIMUM RUNOFF FREQUENCY CURVES
WEST RIVER AT NEWFANE, VERMONT
D.A. = 308 SQ. MI.
PERIOD OF RECORD 63 YRS.

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DROUGHT CONTINGENCY PLAN

RAINFALL AND RUNOFF

GUIDE CURVES FOR
NEW HAMPSHIRE AND VERMONT

APPENDIX B

ECONOMIC ASSESSMENT

ECONOMIC ASSESSMENT OF
DROUGHT CONTINGENCY WATER SUPPLY PRICING
at MANSFIELD HOLLOW LAKE RESERVOIR

APPENDIX B

PREPARED BY:
ECONOMIC AND RESOURCE ANALYSIS BRANCH
IMPACT ANALYSIS DIVISION
PLANNING DIRECTORATE

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

JULY 1991

ECONOMIC ASSESSMENT OF
DROUGHT CONTINGENCY WATER SUPPLY PRICING
at MANSFIELD HOLLOW LAKE RESERVOIR

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INTRODUCTION

The purpose of this report is to develop a methodology to be used to develop a price for drought contingency water supply. The methodology is developed in accordance with ER 1105-2-100, Chapter 4, Section 7 with the exception of including updated construction cost as an element of the price to be charged to the non-federal user.

METHODOLOGY

The amount to be charged for drought contingency water is determined by finding the appropriate share of joint cost attributed to drought contingency water supply, obtaining all cost that can be attributed to the provision of drought contingency water, and accounting for any benefits forgone from the existing project due to the provision of drought contingency water.

The joint cost of providing water is determined by deducting specific cost from total operation, maintenance, replacement and major rehabilitation. The non-federal share of joint cost applied to drought contingency is determined by dividing the volume in acre-feet devoted to drought contingency water supply by the total usable storage space in acre-feet. This ratio is then multiplied by annual joint use cost to determine the non-federal share.

To the joint use annual cost is added any separable cost that is due entirely to the drought contingency water supply function. Reductions in project benefits are then calculated (if any) and added to the non-federal share.

The price will be determined on an annual basis and updated for each year of the drought contingency water supply contract with the non-federal user.

WATER SUPPLY PRICE

The development of a price to be charged the non-federal user is shown in Table 1.

Joint Use Cost

Joint Use Cost is project cost that cannot be separated by type of project benefit. This cost is obtained by deducting from total O & M cost (Column 3) that is specific to recreation (Column 4). The result is shown in Column 5. The share that is attributed to water supply is obtained by dividing acre-feet available for drought contingency water supply (Column 1) by total acre-feet of available storage (Column 2). This factor is then multiplied by joint use O&M (Column 5) and Rehabilitation and Replacement (Column 6) to determine that portion of joint cost that is to be allocated to drought contingency water supply. The result is shown in columns 9 and 10.

Table 1
Drought Contingency
Water Supply Pricing
1991 Price Level

RESERVOIR	WS-VOL (AC-FT)	TOT-VOL (AC-FT)	TOT O&M (000)	REC O&M (000)	JT O&M (000)	JT REHAB (000)	SEP WS (000)	LOST REC (000)	JT O&M-WS (000)	REHAB-WS (000)	WS-ANN'L	WS-DAILY
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
MANSFIELD HOL.	680	49,200	272.7	11.8	260.9	45	0	0	3.6	0.6	\$645.	\$11.51

Benefits Foregone

Recreation benefit at Mansfield Hollow Lake would not be affected by the water supply function. Recreation activities provided at Mansfield Hollow Lake allow for boating, picnicking, fishing, hunting, hiking, and playing ball. Swimming is not allowed due to the close location to the Willimantic water supply. The provision of a drought contingency pool does not affect recreation activities at Mansfield Hollow Lake.

SUMMARY

The daily price to be charged for drought contingency water supply (Table 1, Column 12) is obtained by adding water supply's share of joint O&M and major rehabilitation and replacement cost (Cols. 9 and 10) and dividing by 365. To this is added separable water supply cost and foregone recreation value. These latter two magnitudes are put on a daily basis by dividing by 56 days which is the period that drought contingency water supply would be available. Annual cost shown in Col. 11 is obtained by multiplying col. 12 by 56.

Drought contingency water supply price should be established for a period of one year and updated in successive years based upon changes in O&M, major rehabilitation and replacement and recreation value.

APPENDIX C

WATER QUALITY EVALUATION

APPENDIX C

WATER QUALITY EVALUATION
MANSFIELD HOLLOW LAKE DROUGHT CONTINGENCY STUDY
MANSFIELD HOLLOW, CONNECTICUT

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APPENDIX C

WATER QUALITY EVALUATION MANSFIELD HOLLOW LAKE DROUGHT CONTINGENCY STUDY MANSFIELD HOLLOW, CONNECTICUT

1. SUMMARY

Drought contingency storage at Mansfield Hollow Lake would raise the pool 1.5 feet above its current elevation of 211.5 to 213.0 feet NGVD, from a maximum depth of 16.5 to 18.0 feet. This increase would only occur during a declared drought period. Water quality effects that could result from drought storage include decreases in dissolved oxygen, and increases in water temperature, iron, manganese, phosphorus, ammonia, color, and suspended solids. These increases would be minor and are not expected to threaten aquatic life or human health. Although the lake would be subject to a greater potential for the occurrence of localized algae blooms, severe algae problems are not anticipated and trophic status of the lake should remain unchanged. Effects of drought storage operations on downstream water quality are expected to be minimal as well. The waters of Mansfield Hollow Lake would require standard treatment processes for drinking water supply, but no treatment would be necessary for fire-fighting, irrigation, and most industrial uses in the event of drought storage implementation.

2. WATER QUALITY CLASSIFICATION

The Mount Hope, Fenton, and Natchaug Rivers and their tributaries above Mansfield Hollow Lake are rated class B/AA by the Connecticut Department of Environmental Protection (DEP). According to the DEP, class B/AA waters are intended to eventually meet class AA water quality criteria, although they may not at the present time. Class AA waters are designated acceptable for an existing or proposed drinking water, agricultural, or industrial supply; fish and wildlife habitat; and recreation unless restricted because of potential bacterial contamination of a drinking water supply.

Technical requirements for class AA waters include a minimum dissolved oxygen concentration of 5 mg/l, a maximum turbidity level of 10 JTU's, no fecal coliform bacteria in excess of an arithmetic mean of 20 organisms per 100 ml sample, and a 20 mg/l maximum sodium concentration. These standards further prohibit color, pH, phosphorus, taste or odor except as naturally occurs; and chemical constituents in concentrations or combinations harmful to the most sensitive designated water use.

3. EXISTING WATER QUALITY CONDITIONS

a. General. Relatively few sources of pollution contribute to the Mansfield Hollow Lake watershed, consequently, the waters are of high quality. Furthermore, the lake is mesotrophic with low mean hydraulic detention times, weak thermal stratification patterns and no significant algae problems.

b. Watershed Land Use. Drainage area at Mansfield Hollow dam includes 159 square miles of which 39 are drained by Fenton River, 35 by Mount Hope River, and the remaining area is drained by the Natchaug River.

Mansfield Hollow Lake watershed is rural with relatively little residential and no industrial development. The land is mostly wooded, with some fields, and many swamps and marshes. The Corps leases 318 acres within the reservoir area for hay and corn cultivation. In accordance with the lease, pesticides and chemical fertilizers capable of contaminating groundwater or floodwaters are not allowed.

No point source discharges from industries or municipalities empty into rivers upstream from Mansfield Hollow Lake. Although heavy residential development is not prevalent in the drainage basin, the rivers are subject to a few non-point source discharges. As listed in the State of Connecticut's 1988 Water Quality Report to Congress, non-point sources of pollution include agricultural, highway, and highway maintenance runoff into the Natchaug River, while runoff from landfills potentially contaminate the waters of the Mount Hope and Fenton Rivers.

c. Water Quality Conditions. The waters of Mansfield Hollow Lake are of high quality, usually meeting or exceeding Connecticut class AA requirements. Water quality data collected at inflow and discharge stations through the NED sampling program since 1971 show consistently high dissolved oxygen and low turbidity levels. Minor areas of concern include occasionally high fecal coliform and algal nutrients levels, and slightly low pH levels. Also, high levels of color, iron, and manganese in these waters may be of concern to potential water supply users.

Examples of excellent water quality constituents at Mansfield Hollow Lake include high dissolved oxygen levels which always meet State standards and very low turbidity measurements which have only exceeded standards twice since monitoring began. Also, metals levels are fairly low and do not threaten human health or aquatic life.

Coliform bacteria levels often exceeded criteria in the beginning of the monitoring program; however, the most recent data indicate no violation for this bacteria. Since no industry or municipality discharges upstream from the impoundment, coliform levels are expected to remain low except when runoff events wash highway, agricultural, landfill, and other potential pollutants into the rivers.

Nutrients levels are fairly high at inflow and discharge stations, particularly nitrites and nitrates, and to a lesser degree, phosphorus. Measurements often exceed threshold concentrations capable of supporting algae blooms in an impoundment. Even though nutrients are abundant in these waters, nuisance algae blooms have never been observed in Mansfield Hollow Lake probably because the waters are not retained in the lake for extended periods.

Mean pH levels usually fall within the recommended 6.5 to 8.0 range. However, pH at this project tends to be on the acidic side of this range with measurements frequently dropping just below the 6.5 minimum.

Moderate color levels and high iron and manganese levels are common in the waters of Mansfield Hollow Lake. Iron and manganese measurements frequently exceed drinking water supply limits established by the EPA. These limits are set for aesthetic purposes and to prevent taste and laundry staining problems. Present concentrations of iron and manganese present are not a health hazard to humans or aquatic life. High color, iron and manganese and low pH levels found in these waters most likely originate from numerous swamps and marshlands in the watershed.

d. Reservoir Conditions. The water of Mansfield Hollow lake is currently utilized by the Willimantic Water Works at Willimantic Reservoir in Windham, CT. This reservoir, located about two miles downstream from Mansfield Hollow Dam on the Natchaug River, maintains water supply storage for the city of Willimantic. As a result, swimming is not allowed at Mansfield Hollow Lake, although the lake is used for most other recreational activities such as boating and fishing.

Water temperatures in the lake and its tributaries provide good habitat for warm water fish species. These waters also provide a satisfactory cold water fish habitat until early summer when temperatures usually exceed 70° Fahrenheit. The three tributaries to Mansfield Hollow Lake and sections of the Natchaug River below the lake and before the reservoir are annually stocked with trout.

Based on the fairly warm water temperatures, moderate to high levels of nutrients and the absence of nuisance algae blooms, Mansfield Hollow lake most closely resembles a mesotrophic waterbody. A lake of this trophic status will rarely experience major algae blooms; however, occasional local blooms would be expected.

A recreation pool is maintained at elevation 211.5 feet, NGVD from May until November. At this elevation, Mansfield Hollow Lake covers a surface area of about 450 acres to a maximum depth of 16.5 feet. Mean hydraulic residence times of 13, 14, and 11 days were calculated for July, August, and September, respectively. These are based on average monthly Natchaug River flows measured by the US Geological Survey for the period of record (1931 to 1990) at the Willimantic, CT gaging station, located 3.7 miles downstream from the dam.

Lake profiling data were collected in 1987 at this project and incorporated in the July 1988 "Mansfield Hollow Lake Water Quality Evaluation" produced by NED. According to this detailed study, Mansfield Hollow lake exhibits weak, thermally-induced density stratification patterns which form, break up, and reform during the summer. This stratification forms on calm, sunny days, but can break up during high winds, at night, or on cool, cloudy days. Throughout stratification periods the lake is not clearly divided into the epilimnion, thermocline, and hypolimnion of classical stratification. During mid-summer, however, small pockets of relatively stagnant water tend to form at the bottom of the lake where dissolved oxygen levels can go anaerobic.

4. WATER QUALITY REQUIREMENTS OF DROUGHT STORAGE

Two water quality requirements must be achieved for municipal storage. The waters must meet State and Federal standards for surface waters and must be of a quality suitable for the water supply user. A water which meets class AA standards in Connecticut is usable for drinking water supply if standard treatment processes are used. Water quality requirements for industrial water supply depend on the industrial process involved.

The quality of Mansfield Hollow Lake's waters is acceptable for domestic water supply following the use of conventional treatment processes. As mentioned previously, an existing municipal water supply, Willimantic Reservoir, is located less than one mile downstream from Mansfield Hollow dam. The Willimantic Water Works currently draws and treats water from this reservoir using a complete, conventional drinking water treatment system. Potential drought storage

at Mansfield Hollow Lake will augment the Willimantic Reservoir water supply during periods of reduced flows. To avoid problems with the existing treatment system or the need for additional treatment, the quality of these waters should not be substantially degraded from present conditions as a result of drought storage at Mansfield Hollow Lake.

At present, no other potential municipal or industrial water supply users have shown interest in drought storage at the lake. If interest develops in the future, however, the water quality condition of Mansfield Hollow Lake at recreation pool capacity is suitable for municipal or industrial use following standard treatment processes. In addition, these water would be suitable for fire-fighting or irrigation without treatment.

5. EFFECTS OF INCREASED STORAGE ON NORMAL RESERVOIR WATER QUALITY

Drought contingency storage at Mansfield Hollow Lake would increase the pool 1.5 feet above the existing recreation pool to a water surface elevation of 213 feet NGVD (maximum depth of 18.0 feet) from July to November. This increase would only occur during a declared drought period, changing the lake's volume from 2,800 to 3,480 acre-feet and surface area from 450 to 490 acres. Since very little water quality data during drought is available, the following discussion describes expected water quality changes due to additional storage based on normal flows at the project. Quality of water in the enlarged impoundment may degrade slightly due to the effects of newly inundated acreage, a deeper pool, and longer hydraulic residence times, but these changes would be fairly minor.

Inundation of vegetated lands when the pool is raised will affect water quality by causing a decay of organic material thereby releasing nutrients and metals to the overlying waters. This could lead to increases in color and suspended sediments, and, because of additional nutrients, a greater susceptibility to algae blooms. Raising the pool may also cause sloughing of sediments from wave action and during drawdown events. At Mansfield Hollow Lake, however, water quality degradation due to decay and erosion will probably be minor and localized as the proposed increase in pool size is small relative to the total pool area. Moreover, most of the additional land that would be inundated is reportedly sparsely vegetated.

Increased pool volume and depth strengthen stratification patterns, increasing extent and duration of anaerobic

conditions in the lake. Since stratification patterns are extremely weak at Mansfield Hollow Lake and the proposed drought storage increases overall volume by only 24 percent, a strong hypolimnion probably will not develop due to raising the pool level. However, oxygen deficient pockets located in the depths of the lake could increase in size and duration. Sediments in areas devoid of oxygen become chemically reduced causing iron, manganese, ammonia and phosphorus to become soluble and diffuse into the overlying waters. Ammonia also tends to increase under reduced dissolved oxygen conditions due to the reduction of nitrite and nitrate. Increases in the above constituents promote the potential for algae problems.

Enlarging the pool will also increase mean hydraulic residence times by 3 or 4 days to 16, 18, and 14 days for July, August, and September, respectively. Longer hydraulic residence times reduce flushing of the system which promotes warming of the waters. Warmer waters will strengthen thermal stratification patterns further increasing the amount and duration of anaerobic pockets in the lake's bottom. Consequently, iron, manganese, ammonia and phosphorus concentrations may increase somewhat in the waters of Mansfield Hollow Lake. Warmer water may slightly degrade cold water fish habitat in the impoundment and downstream from the dam. Higher temperatures and nutrients concentrations can also cause algae problems, although, these are expected to be localized and nuisance blooms across the lake are not anticipated. However, since mean detention times of the proposed impoundment would only increase by 3 or 4 days, water quality effects should be minimal with little change to the trophic status.

6. EFFECTS OF REDUCED FLOWS ON WATER QUALITY DURING DROUGHT

Drought storage is proposed at Mansfield Hollow Lake to supply additional water to downstream municipalities or industries, specifically the existing Willimantic Reservoir, in the event of a drought emergency. Drought storage would begin mid-spring, generally reaching the required 213 feet NGVD by July. The following paragraphs discuss how normal water quality could change as a result of reduced flows at the project during drought.

Droughts or long periods of low flow can have a pronounced effect on water quality. Reduced flows in streams are undesirable because stream temperatures tend to increase due to reduced depths and velocities, and dissolved oxygen levels tend to drop due to increased temperatures and reduced assimilative capacities. On the other hand, since no

industries or municipalities discharge into Mansfield Hollow Lake's watershed, less fecal coliform, nitrates and nitrites are washed into the rivers during droughts. As a result, these constituents may decrease during low flow periods in the Mount Hope, Fenton, and Natchaug Rivers, which are subject to agricultural, highway and landfill runoff. Overall, however, the undesirable effects of droughts outweigh any improvements in some water quality parameters.

In addition to the degraded water quality of its tributaries during droughts, decreased flows at Mansfield Hollow Lake will cause hydraulic detention times to increase significantly. Based on minimum monthly Natchaug River flows for the period of record (1931-1990) at the Willimantic, CT gaging station, maximum hydraulic detention times in the proposed drought storage pool for July, August, and September would be 150, 180, and 160 days, respectively. With these detention times, the lake would become virtually stagnant and associated water quality degradation caused by increased temperatures and more extreme stratification patterns can be expected.

Effects of drought on water quality, however, will occur regardless of the increase in pool size to accommodate drought storage. Maximum hydraulic detention times for the recreation pool alone during July, August, and September were estimated to be about 120, 140, and 130 days, respectively. At these levels, the lake will also experience almost complete stagnation and significant water quality degradation. Since maximum detention times for the proposed drought storage pool are not that much longer than those for the recreation pool alone, water quality degradation would be similar in nature, but somewhat more severe.

At Mansfield Hollow Lake, the recreation pool level is normally controlled by a weir which draws water from the lake's surface and inhibits oxygenation of water at the bottom, especially during low flow periods. If drought releases were made using the gates, water from the bottom of the pool would be released somewhat reducing stagnation and stratification. Making a small release through the gates during non-drought periods would also improve pool water quality.

7. EFFECTS OF DROUGHT STORAGE OPERATIONS ON DOWNSTREAM WATER QUALITY

Under the present mode of operation, releases at Mansfield Hollow equal inflow except during flood storage periods when minimum outflow is limited to about 15 cfs, the

all season 7-day, 10-year experienced low flow (7Q10). Under the drought contingency plan, filling of the drought storage pool would likely occur in May and June upon notification of a drought emergency. A minimum release of 40 cfs, the 7Q10 calculated for the months of May through June, would be maintained during the filling operation. As a natural minimum flow of that season, this release should provide downstream water quality comparable with naturally experienced conditions. Small increases in temperature and decreases in dissolved oxygen would occur during filling, but probably not enough to impair downstream aquatic habitat.

Once the pool reaches the drought storage elevation of 213.0 feet NGVD, reservoir releases would be maintained equal to inflow. Any minor water quality degradation would then be due to effects of increased storage as previously discussed. During drawdown of the drought storage pool (between July and October), minimum reservoir releases would augment natural inflow causing favorable effects on temperature, DO, water depth and velocity in the Mansfield Hollow tailwater.

8. CONCLUSIONS

A pool increase from 211.5 to 213.0 feet NGVD during a drought emergency would have some effects on water quality; however, these effects would likely be minor. Water quality changes that can be expected at Mansfield Hollow Lake as a result of increased storage include higher water temperatures, lower dissolved oxygen levels, and increases in iron, manganese, phosphorus, ammonia, color and suspended solids. In consequence, the lake would be subject to a greater potential for the occurrence of localized algae blooms; however, severe algae blooms are not anticipated.

Since the water at Mansfield Hollow Lake has been historically of high quality, effects of drought storage should be minimal. Water temperatures may increase slightly, but probably not enough to significantly impair cold water fish spawning and growth. Also, these waters are well cushioned against decreases in dissolved oxygen as levels are already quite high, and against increases in ammonia since levels are fairly low. Increases in iron, manganese and color are not expected to be high enough to be harmful to humans or aquatic life. Also, increases in suspended sediment from the newly inundated lands should be localized and not significantly change overall water quality.

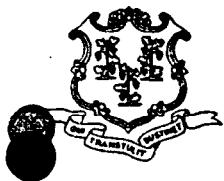
Unfortunately, lake waters tend to stagnate and most water quality conditions generally worsen during droughts. This situation would happen during extreme low flow periods

regardless of drought storage. If drought storage releases were made using the flood control gates, as opposed to the weir, some reduction in stagnation may occur during droughts due to discharges from the bottom of the pool. These low level releases should not alter downstream water quality since the water would become reoxygenated from turbulence within the outlet works. Releases would always be greater than or equal to inflow, except during the drought storage pool filling operation in the spring. During filling of the drought pool, the required minimum release would be the natural minimum 7Q10 flow of the May-June season. Consequently, downstream water quality degradation due to drought storage operations is expected to be minimal.

Standard treatment processes would be necessary to use the waters of Mansfield Hollow Lake for drinking water supply if drought storage were implemented. Thus, the processes currently used to treat the Willimantic Reservoir water supply, located just downstream of Mansfield Hollow dam, should not have to be upgraded as a result of drought storage. Furthermore, no treatment would be required for the water to be suitable for fire-fighting, irrigation, or various industrial processes.

APPENDIX D

SPONSORSHIP AND LOCAL CONTINGENCY PLANNING



STATE OF CONNECTICUT

DEPARTMENT OF HEALTH SERVICES

June 12, 1991

Mr. Richard D. Reardon, Dir. of Eng.
Department Of The Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02554-9149

Dear Mr. Reardon:

In response to your request regarding drought emergency planning, I am writing to express the interest of the Connecticut Department of Health Services in participating in the Mansfield Hollow Drought Contingency Plan.

I will be our Department's contact person on this plan and will be assisted by Ms. Denise Ruzicka of our Planning Unit. Please feel free to contact me or her at (203) 566-1253 should you have any questions.

Sincerely,

Gerald R. Iwan, Ph.D.
Chief, Water Supplies Section

GRI/DR/ch

cc: Paul Schur
James Okrongly
Denise Ruzicka
Raymond Jarema
File: Mansfield Hollow

2805E

566-1253

Phone:
150 Washington Street - Hartford, Connecticut 06106
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P R E L I M I N A R Y D R A F T

DROUGHT EMERGENCY WATER CONTRACT
BETWEEN THE UNITED STATES OF AMERICA
AND
THE STATE OF CONNECTICUT DEPARTMENT OF HEALTH SERVICES
FOR
DROUGHT EMERGENCY WATER FROM MANSFIELD HOLLOW LAKE
MANSFIELD AND WINDHAM, CONNECTICUT

THIS CONTRACT, entered into this _____ day of _____, 19____, by and between the UNITED STATES OF AMERICA (hereinafter called the "Government") represented by the Contracting Officer executing this contract, and THE STATE OF CONNECTICUT DEPARTMENT OF HEALTH SERVICES, (hereinafter called the "User"); represented by ??????????????.

WITNESSETH THAT:

WHEREAS, pursuant to Public Law 97-228, the Congress approved the Flood Control Act of 18 August 1941, the Government has constructed and is operating Mansfield Hollow Lake , (hereinafter called the "Project"); and,

WHEREAS, Section 6 of the Flood Control Act of 1944 (Public Law 78-534), as amended, provides that the Secretary of the Army is authorized to make contracts with states, municipalities, private concerns, or individuals, at such prices and on such terms as he may deem reasonable, for domestic and industrial uses for drought emergency water that may be available at any reservoir under his control provided that no contracts for such water shall adversely affect the existing lawful uses of such water; and,

WHEREAS, the User desires to contract with the Government for the privilege of withdrawing drought emergency water from the Project;

NOW, THEREFORE, the parties do mutually agree as follows:

ARTICLE 1

Water Supply and Withdrawals.

a. The Government will reserve 680 acre feet of storage space in the Project in order to meet the water demands of the User. From this storage space the User shall have the privilege of withdrawing all of the water in the said storage space during the term of this contract as specified in Article 6 hereof. In the event the user needs an amount of water in excess of the aforesaid 680 acre feet the government shall determine if releases in excess of 680 acre feet are feasible in accordance with paragraph 8 of Exhibit A.

b. The User shall have the right to construct, operate and maintain installations and facilities, or to contract with third parties therefore, for the purpose of withdrawing water from the Project, subject to the approval of the Contracting Officer as to design and location of such installation and facilities. All costs associated with such installations and facilities or any modifications thereof or any future construction in connection therewith, shall be without expense to the Government.

c. The Government reserves the right to maintain at all times minimum downstream releases through the gates or spillway of the dam to meet established water requirements. The Government further reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property, including the right not to make downstream releases during such periods of time as are deemed necessary, in its sole discretion, to inspect, maintain, or repair the Project.

d. The User recognizes that this contract provides storage space for raw water only. The Government makes no representation with respect to the quality or availability of water and assumes no responsibility therefor, or for treatment of the water. The water level of the Project will be maintained at elevations which the Government deems will best serve the authorized purposes of the Project, and this contract shall not be construed as giving the User any rights to have the water level maintained at any elevation. The User further recognizes that it is acquiring no permanent right to the use of storage in the Project.

e. The parties agree that any actions by the Government to store waters and any rights to releases of said stored water shall be governed by the provisions of a document entitled DROUGHT CONTINGENCY PLAN MANSFIELD HOLLOW LAKE dated ???? and appended hereto as Exhibit A. The said document consisting of the report and appendices A through D are hereby incorporated into this agreement by reference.

ARTICLE 2

Metering

For the purpose of maintaining an accurate record of the water released from the Project, the Government agrees to maintain records of the releases made. Such records shall include, at a minimum, the time of each release and the amount of each release.

ARTICLE 3

Federal and State Laws

a. The User shall utilize the water withdrawn from the Project in a manner consistent with Federal, State, and local laws.

b. The User furnishes, as party of the contract, an assurance

(Exhibit A) that the User will comply with Title VI of the Civil Rights Act of 1964 (78 Stat. 252; 42 U.S.C. 2000d, et seq) and Department of Defense Directive 5500.11 issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations. The said assurance is attached hereto and incorporated by reference.

c. Any discharges of water or pollutants into a navigable stream or tributary thereof resulting from the User's facilities and operations undertaken under this contract shall be performed only in accordance with applicable Federal, State and local laws and regulations.

ARTICLE 4

Regulation of the Use of Water

The regulation of the use of and water rights needed for the water withdrawn or released from the storage space shall be the sole responsibility of the User and under the sole authority of the User in accord with Federal, State, and local laws and shall not be considered a part of this contract. The Government shall not be responsible for the use of water by the User, nor will it become a party to any controversies involving the water use, except as such controversies may affect the operations of the Project.

ARTICLE 5

Consideration and Payment

(a) In consideration of the right to make withdrawals from the Project for municipal and industrial water supply purposes, during periods of drought emergency as defined below the User agrees to pay the Government the sum of One Dollar (\$1) per year. This payment is due within thirty days of the effective date of this contract. The agreed fee for the 680 acre feet stored for the user is \$645. This payment shall be due and payable in full within thirty days of the declaration of a drought emergency by the Governor of Connecticut subsequent to the first drought of the five year contract period. The fee per acre foot for those amounts of water released in excess of 680 acre feet shall be computed by dividing 680 acre feet by the current rate for that amount of water and multiplying the result by the quantity of water in excess of 680 acre feet released to the user.

(b) The repayment amount(s) shown in Article 5(a) is based upon those factors set forth in Appendix B attached to Exhibit A.

(c) If the User shall fail to make any payment under this contract within thirty (30) days of the date due, interest thereon shall accrue at the rate as determined by the Department of Treasury; Treasury Fiscal Requirements Manual (1 TFRM 6-8000, "Cash Management") and shall compound annually from the date due until paid. This provision shall not be construed as waiving any other rights the Government may have in the event of default by the User,

including but not limited to the right to terminate this contract for default.

ARTICLE 6

Duration of Contract

This contract shall become effective as of the date of the approval by the Contracting Officer, and shall continue in full force and effect under the conditions set forth herein, for a period of not to exceed 5 years from the said date of approval. Upon expiration, this contract may be extended by mutual agreement for additional periods of not to exceed 5 years each. All such contract extensions shall be subject to recalculation of reimbursement and other fees.

ARTICLE 7

Termination of Contract

a. Either party may terminate this contract and the privilege of withdrawing water upon 30 days written notice. In the event of termination under this paragraph, the Government will make pro rata refund for any balance of the contract term for which payment has been made and the User will pay all charges which have accrued through the date of the termination.

b. The Government may terminate this contract and the privilege of withdrawing water upon ninety (90) days written notice, if the User shall default in performance of any obligation of this contract. Upon such a termination, User shall continue to be liable to the Government for any monies owed and for any costs incurred by the Government as a result of the default.

c. In the event of any termination pursuant to this Article or Article 6, User shall, upon request of the Contracting Officer, promptly remove, at User's own expense, any facilities constructed on Project land for water withdrawal and restore premises around the removed facilities to a condition satisfactory to the Contracting Officer.

ARTICLE 8

Rights-of-Way

Occupancy and use of Project lands shall be in accordance with any permits, rights-of-way, or easements granted to the User by the Government.

ARTICLE 9

Release of Claims

The User shall hold and save the Government, including its

officers, agents, and employees, harmless from liability of any nature or kind for or on account of any claim for damages which may be filed or asserted as a result of the withdrawal or release of water from the Project made or ordered by the User, or as a result of the construction, operation or maintenance of any facilities or appurtenances owned and operated by the User except for damages due to the fault or negligence of the Government or its contractors.

ARTICLE 10

Transfer or Assignment

The User shall not transfer or assign this contract nor any rights acquired thereunder, nor suballot said water or storage space of any part thereof, nor grant any interest, privilege or license whatsoever in connection with this contract, without the approval of the Secretary of the Army or his duly authorized representative provided that, unless contrary to public interest this restriction shall not be construed to apply to any water which may be withdrawn or obtained from the water supply storage space by the User and furnished to any third party or parties or to the rates charged therefor.

ARTICLE 11

Officials Not to Benefit

No member of or delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

ARTICLE 12

Covenant Against Contingent Fees

The User warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the User for the purpose of securing business. For breach or violation of this warranty, the Government shall have the right to annul this contract without liability, or in its discretion, to add to the contract price or consideration the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE 13

Environmental Quality

During any construction, operation, and maintenance by the User of any facilities, specific actions will be taken to control

environmental pollution which could result from such activity and to comply with applicable Federal, State and local laws and regulations concerning environmental pollution. Particular attention should be given to (1) reduction of air pollution by control of burning, minimization of dust, containment of chemical vapors, and control of engine exhaust gases, and of smoke from temporary heaters; (2) reduction of water pollution by control of sanitary facilities, storage of fuels and other contaminants, and control of turbidity and siltation from erosion; (3) minimization of noise levels; (4) onsite and offsite disposal of water and spoil; and (5) prevention of landscape defacement and damage.

ARTICLE 14

Approval of Contract

This contract shall be subject to the written approval of the Secretary of the Army or his duly authorized representative and shall not be binding until so approved.

IN WITNESS WHEREOF, the parties have executed this contract as of the day and year first above written.

APPROVED:

THE UNITED STATES OF AMERICA

By _____
(Contracting Officer)

[Insert name of User]

DATE: _____

By _____
[Title]

WILLIMANTIC WATER WORKS, WINDHAM, CT ^{1/}
WATER SHORTAGE CONTINGENCY PLAN

TRIGGERS

1. ALERT

A. Stream flow through the Willimantic Reservoir drops below 10 CFS while a normal pool level is being maintained at the Mansfield Hollow Dam.

B. The Utility experiences a Max day demand in excess of 5 MGD, or 2 or more concurrent max days in excess of 4.5 MGD.

2. ADVISORY

A. Stream flow through the Reservoir drops below 8 CFS while a normal pool level is maintained at Mansfield Hollow.

B. The Utility experiences a max day demand in excess of 5.5 MGD or 3 or more concurrent days in excess of 4.5 MGD.

C. A breakdown of treatment facilities affecting plant output is expected to exceed 24 hours.

D. A loss of finished water storage by fire or main break reduces storage below 25%.

E. A chemical spill within the watershed, which DEP and DOHS believe could affect water supply.

RESPONSES

A. Notify DOHS, First Selectman's office and water Commission. Contact major water users and verify consumption, review demand profile to ensure water is not being lost due to leakage.

B. Contact press to coordinate release of information.

A. Step one plus: Curtail nonessential use within the utility.

B. Issue press release requesting voluntary conservation, monitor demand to document reduction in demand.

^{1/}Source: Willimantic Water Works, Windham, CT.

3. EMERGENCY - PHASE 1

A. Stream flow below 6 CFS which would require additional release from Mansfield Hollow.

B. Max Day demand in excess of 6 MGD or concurrent days in excess of 5 MGD.

C. Finished water storage at or below 25% for more than two consecutive days.

D. Chemical spill which in the opinion of DEP and DOHS will affect the water supply for a short duration (less than 24 hours).

A. Continue all actions required under previous Plan stages.

B. Issue press releases.

C. Implement phase I, mandatory conservation of water. Enforcement will be by daily checks by meter readers of large water users.

D. Curtail use by car wash facilities, lawn watering including irrigation practiced by the Willimantic Country Club, Eastern Conn. State College and filling pools. Eliminate use by Public Works Dept. for street sweeping and Sewer Dept. for sewer flushing.

4. EMERGENCY - PHASE II

A. Low stream flows requiring additional release from Mansfield Hollow for a period longer than 30 days.

B. Finished water storage below 10% or failure to recover storage after implementation of Phase I for two days.

C. Chemical spill which DEP and DOHS determined will affect the water supply for up to (48 hours).

A. Continue all actions required under previous Plan stages.

B. Curtail non essential uses for all customers. Conduct media campaign. Monitor demand and document reductions. Curtail use for the following Industrial/Commercial customers: Brintec, Rogers, Windham Energy Resource Facility, Bricktop Laundry, Coin o' Matic laundry, Willi Car Wash, Eastern College Physical Ed. Building, Establish civil penalty's for noncompliance with mandatory conservation measures. Have Water Personnel patrol system and conduct frequent meter reading spot checks.

C. Issue appropriate press releases.

5. EMERGENCY - PHASE III

A. Depletion of 75% of the Mansfield Hollow Pool level.

B. Loss of treatment capability for more than 36 hours.

C. Loss of finished water storage.

D. Chemical spill which DEP and DOHS determine will affect the water supply for more than 36 hours.

A. Continue all actions required under previous Plan stages.

B. Impose strict rationing of water use, including shutting off water for noncompliance. Maintain service to essential users including: Hospitals and outpatient centers, Elderly and nursing homes, schools and other public facilities. Facilities which will be opened to the public for bathing and obtaining drinking water should be announced through the media.

